CONSTRUCTIONMAN

BUREAU OF NAVAL PERSONNEL

RATE TRAINING MANUAL NAVPERS 10630-E

PREFACE

This training manual was prepared for men of the Navy and Naval Reserve who are studying for advancement to the rate of Constructionman. Combined with the necessary practical experience, a knowledge of the information in this training manual will help the reader meet qualification requirements for advancement.

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THE UNITED STATES NAVY

GUARDIAN OF OUR COUNTRY

The United States Navy is responsible for maintaining control of the sea and is a ready force on watch at home and overseas, capable of strong action to preserve the peace or of instant offensive action to win in war.

It is upon the maintenance of this control that our country's glorious future depends; the United States Navy exists to make it so.

WE SERVE WITH HONOR

Tradition, valor, and victory are the Navy's heritage from the past. To these may be added dedication, discipline, and vigilance as the watchwords of the present and the future.

At home or on distant stations we serve with pride, confident in the respect of our country, our shipmates, and our families.

Our responsibilities sober us; our adversities strengthen us.

Service to God and Country is our special privilege. We serve with honor.

THE FUTURE OF THE NAVY

The Navy will always employ new weapons, new techniques, and greater power to protect and defend the United States on the sea, under the sea, and in the air.

Now and in the future, control of the sea gives the United States her greatest advantage for the maintenance of peace and for victory in war.

Mobility, surprise, dispersal, and offensive power are the keynotes of the new Navy. The roots of the Navy lie in a strong belief in the future, in continued dedication to our tasks, and in reflection on our heritage from the past.

Never have our opportunities and our responsibilities been greater.

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CHAPTER 1

THE SEABEES AND THE CONSTRUCTIONMAN

As you commence the study of this training manual, you may have orders to report to one of the Naval Mobile Construction Battalions, an Amphibious Construction Battalion, a Class "A" School at one of the Construction Battalion Centers, or one of the other types of SEABEE units described later in this chapter. Regardless of where your first duty assignment takes you, the most important part of your naval career lies ahead. More important yet is the fact that you are now a member of that elite group known as the Navy's SEABEES!

This chapter contains a brief history of the SEABEES and the Civil Engineer Corps. It also covers the many types of SEABEE units within the Naval Construction Force, their mission, and their relationship to other Navy units. A brief description of all seven Construction (Group VIII) ratings is also included. If you are not yet a designated striker, then perhaps the study of this training manual will help you in deciding which rating to strike for. Of course, you must be aware that in order to strike for a particular rating in the Navy, you must first meet such minimum requirements as personal capability, aptitude, educational achievement, experience, and the like. If you are a designated striker, then undoubtedly you have already demonstrated these qualities to the classification interviewer at bootcamp. You may be designated a striker when, as a CN, you pass the examination for one of the ratings at the petty officer third-class level, but not be advanced due to quota limitations. (The Navy rating structure is explained later.)

HISTORY OF THE SEABEES

The SEABEES are the Navy's construction forces and few select teams, if any, enjoy a finer reputation among America's fighting men. During their short history, the SEABEES have won fame, honor, and distinction as an organization that "Can Do," even when faced with practically insurmountable obstacles. A brief discussion on the history of the SEABEES is given below.

THE CIVIL ENGINEER CORPS

No discussion on the history of the SEABEES is complete without first explaining the origin and purpose of the Civil Engineer Corps (CEC). The CEC is composed of dedicated staff corps officers who are specialists in the field of civil engineering. A CIVIL ENGINEER is a professional engineer who performs a variety of engineering work in planning, designing, and overseeing construction and maintenance of structures and facilities, such as roads, airports, bridges, harbors, pipelines, powerplants, and water and sewage systems.

Civil engineers have been an integral part of the Navy since its very beginning. Our first "fleet" consisted of less than 10 ships. However, our forefathers realized that in order to survive as a nation, the United States must have a Navy powerful enough to counter the naval threat from pirates and other great powers, such as England, France, and Spain. In order to meet this threat, Congress authorized the hiring, purchasing, and building of several additional vessels. Suitable land for use as navy yards had to be located, surveyed, and purchased. Logically, civil engineers were delegated to perform these tasks.

By the time Thomas Jefferson became President, the Secretary of the Navy, Mr. Stoddert, had established six navy yards. All were managed by civil engineers, although they were not yet known as Civil Engineer Corps officers. In the following years, the number of ships increased sharply as well as the need for more drydocks and repair facilities. The United States was emerging as a great seapower and governmental functions were becoming more complex. As a result, on 31 August 1842, Congress established the "Bureau" system. The Bureau of Yards and Docks (BUDOCKS)—known now as the Naval Facilities Engineering Command (NAVFAC)—

was created at that time, and the Chief of this Bureau was a civil engineer. It wasn't until 25 years later, however, that the Civil Engineer Corps was officially named and authorized. The officers in the Corps at that time were the forerunners of the CEC officers who lead the variety of SEABEE units today. Your company commander will be a CEC officer. Many of these young officers are new to the SEABEES, as you are, and you will both be "learning the ropes" at your respective levels.

As naval technology advanced in the modern era, the navies of the world ranged far over the great oceans. Ships grew more and more dependent upon an ever increasing chain of sophisticated shore bases for their support, both at home and abroad. The construction of these bases necessitated a new and large organization of seafaring fighter-builders.

Before 1941, the Civil Engineer Corps utilized private contractors to accomplish all overseas construction. The contractors in turn hired steelworkers, electricians, carpenters, draftsmen, and mechanics from private industry. However, the Navy realized that, in the event of war, civilian contractors and construction workers could not be used very well outside our own country. If they were attacked and attempted to defend themselves, these civilians could be regarded as guerillas. Also, since most of them had never received any type of combat training, there was reason to believe that they could not adequately defend themselves, even if their lives depended on it. These fears soon became realities.

As World War II drew near, there was an urgent need for more overseas bases. Airfields and landing strips had to be rushed into existence on far away islands. It was all too clear that we needed a combat MILITARY ORGANIZATION trained to construct these advance bases. Even before the outbreak of hostilities, the Bureau of Yards and Docks had conceived the idea of naval construction battalions. The first construction units were organized early in January, 1942. Highly skilled construction workers were recruited and whole construction outfits volunteered men and equipment.

THE FIRST SEABEES

The name SEABEES is derived from these first construction units, or Construction Battalions (CB's) as they were called. Officially, permission to use the name "SEABEE" was granted on 5 March 1942, and each year March 5th is observed as the anniversary of the SEABEES.

Due to the urgent need for these men, the first SEABEES had no time for military training. They were given medical shots, handed equipment, and sent off to pick up where the civilian contractors left off. One month after the first units were organized, SEABEES were at work constructing roads on Borabora, one of the Society Islands, thousands of miles out in the Pacific Ocean.

Little time was given to training the next group of recruits, who were old hands in the construction trades, averaging 31 years of age. Since they were experienced in their respective skills, they needed and received mostly military training. Some additional instruction in technical matters, which were peculiar to the Navy, such as pontoon assembly, was also given these men.

Throughout World War II the SEABEES were without construction ratings as we know them now. They were given the most appropriate existing Regular Navy rating on the basis of their civilian vocation and experience. For example, an experienced steelworker or plumber who had achieved a position of responsibility—perhaps as a foreman or owner of a small business—was rated First Class or Chief Shipfitter. SEABEES who held this and other such ratings as Boatswain's Mate, Machinist's Mate, and Electrician's Mate were easily distinguished from corresponding shipboard ratings by the SEABEE insigne shoulder patch. This now famous insigne consists of a flying bee—fighting mad—with a "whitehat" on his head, a spitting "tommygun" in his front hands, a wrench in his middle hand, and a carpenter's hammer in his rear hand.

Soon the SEABEES had grown enough to have their own stations, such as Camp Endicott, Camp Allen, and Camp Bradford. Camp Peary, near Williamsburg, Virginia, became the receiving and training station for the SEABEES. At these camps, they learned such things as combat formations, combat signals, fire control, combat orders, first aid, use of various weapons, and military courtesy. Instruction was also given in trail cutting and jungle warfare.

After boot training, the new SEABEES were assigned to construction battalions and advanced training began. They learned air raid protection, earthmoving, quonset hut erection, and dry refrigeration. Cross-country marches, sleeping in the open, obstacle courses (fig. 1-1), and simulated combat toughened them up.

29.388
Figure 1-1.—SEABEES going over one of the obstacle courses during combat training at Camp Endicott, Davisville, Rhode Island during World War II.

After this advanced training, battalions were ordered to an advanced base depot, such as Port Hueneme, California or Davisville, Rhode Island, to await transportation overseas. Again, training continued while they were being outfitted with the tools, construction equipment and materials needed to build advance bases and facilities. In addition, they took on stores of ammunition, food, medical supplies—in fact, everything necessary to make them self-sufficient.

By 1943, the training period for SEABEES had expanded to about three months. However, in the spring of 1945, a major change in this training took place: training of organized construction battalions was halted, and emphasis was placed on training individuals to replace the battle-weary veterans due for discharge or rotation back to the States. Even then, time did not permit extensive trade-school type training for these younger, unskilled Selective Service inductees. As a result, experienced personnel in the field had to augment this meager stateside training with a lot of on-the-job training.

SEABEES served with the assault forces in almost every major invasion in World War II, going ashore in most cases with or directly behind the first wave of troops. Such names as Guadalcanal, Los Negros, Tarawa, Munda, Saipan, Tinian, Attu, Iwo Jima, Guam, Samar, Okinawa, Salerno, Sicily, and Normandy will forever be associated with the SEABEES just as "Montezuma" and the "Shores of Tripoli" are symbolic of the traditions associated with the Marine Corps.

Looking back, some of the jobs accomplished by the SEABEES in World War II seemed almost impossible. But they were done—and quickly!

Undoubtedly, this bore the truth of the SEABEES' famous quotation:

> "The difficult task we accomplish right away, the impossible may take a little longer! "

By the way, the SEABEES' official moto is "Construimus-Batuimus." Literally this means, "We Build—We Fight." Even engineers who were used to visualizing large construction projects were amazed at the SEABEES' ability to improvise and build. In the first two years of the war, more than 300 advanced bases of various sizes and kinds were constructed.

In addition to earning the Navy's traditional "well done!" for construction work and defensive combat, the SEABEES also earned well deserved recognition in other capacities. The now famous Underwater Demolition Teams (UDTs) were composed largely of SEABEES. One large group of SEABEES, called Naval Construction Battalions, Special, functioned as stevedores, loading and offloading cargo ships. Other groups included Automotive Repair Detachments, Pontoon Assembly Detachments, Pontoon Operating Battalions, and Construction Maintenance Units. The latter maintained existing bases, releasing full battalions for building new ones.

POST-WAR SEABEES

Since World War II, SEABEES have participated in all kinds of training exercises. They have been part of the naval Antarctic expeditions and they participated in the atomic bomb tests on the Pacific Islands. SEABEES have engaged in constructing overseas bases, such as those at Subic Bay, Philippines and the Marine Corps Air Facility at Futema, Okinawa. They have manned Arctic test stations, and they have been associated with resupply expeditions to Alaska.

SEABEES have continued to be conspicuous in every major operation of the United States Armed Forces. During the Korean War, it was the SEABEES who placed the pontoon causeways for the Inchon landing and provided critical support for the Marines. Again in 1958, during the Lebanon Crisis, SEABEES were there performing the same roles they had in the Korean landings. This time, however, the Marines went ashore to prevent impending hostilities in the Middle-East, and not to assault an enemy position.

Wide diversity has marked the SEABEES in the last decade. During major calamities, such as "Hurricane Camille" on the Gulf coast, and the floods and fires in California, they have been quick to respond to the call for help. Benevolently, they have offered their time, energy, and in some instances their lives while helping to protect the lives and property of others. It is no wonder that they have been called the "Peace Corps" of the United States Armed Forces.

Today, the SEABEES are in Vietnam. They have been there since 1954 when the Geneva Accords divided the country into the free Republic of Vietnam in the South, and the communist Democratic Republic of Vietnam in the North. The division of this country triggered a mass migration of refugees to the South, escaping from communist domination. Upon request, United States Navy ships helped transport over 290,000 refugees to relocation centers in the South. SEABEES of Amphibious Construction Battalion One built camps for many of these displaced Vietnamese during this historic operation—the "Passage to Freedom."

In a short while, the Communist North was attempting to subvert the South, in complete disregard of the Geneva Accords. Using deceit, coercion, and even murder of government officials, the Communists, by the late 1950's, had established a clandestine organization throughout the South known as the Viet Cong. Unable to cope with this situation, the President of South Vietnam requested more military assistance from the United States. This, coupled with the attack on a United States destroyer in the Gulf of Tonkin, South China Sea, marked the beginning of the greatest military involvement by the United States on the mainland of Southeast Asia (SEA). As we increased our military commitment to South Vietnam, our need for more SEABEES in this area also increased tremendously, not only in support of the Marine Amphibious Force, but also those of the other Armed Services, including that of South Vietnam. This sudden buildup tasked construction engineers of all Services beyond their capability. Advance bases and lines of communications had to be established to accommodate this sudden increase in personnel. All types of logistical problems arose and the SEABEES were ordered in to assist in solving them.

In addition to their official military construction mission, volunteer SEABEES have embarked on a massive people-to-people program. This program was initiated to alleviate major hardships endured by the local people, particularly those in rural areas. Volunteers have built and/or renovated schools, churches, hospitals, and other community structures. In many villages,

wells were drilled or dug to provide potable (drinking) water. A SEABEE well drilling crew, assisted by local people, is shown drilling a well in figure 1-2. Medical officers, dental officers, and corpsmen (fig. 1-3) attached to SEABEE units are solving health and sanitation problems during their off duty hours. As far as the Vietnamese are concerned, SEABEES are NUMBER ONE! (This expression is equivalent to "tops" or "outstanding." On the other hand, NUMBER TEN is BAD!)

SEABEE accomplishments and exploits in Vietnam are many, and of course all cannot be mentioned in this text. Outstanding among these was the awarding (posthumously) of the Medal of Honor to CM 3 Marvin G. Shields, USN, the first such honor bestowed upon a SEABEE. Shields gave his life in combat, defending his unit from a communist attack on the morning of June 10th, 1965, at Dong Xoai, Republic of South Vietnam. Undoubtedly, other events will find their way into print, not only in the saga of the SEABEES, but also in the history of our country.

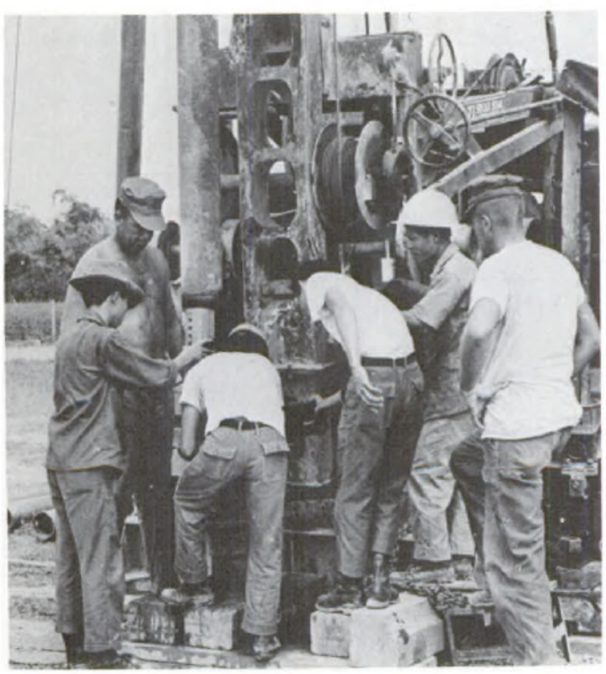

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Figure 1-2.—A SEABEE well drilling crew at work in one of the villages in South Vietnam.

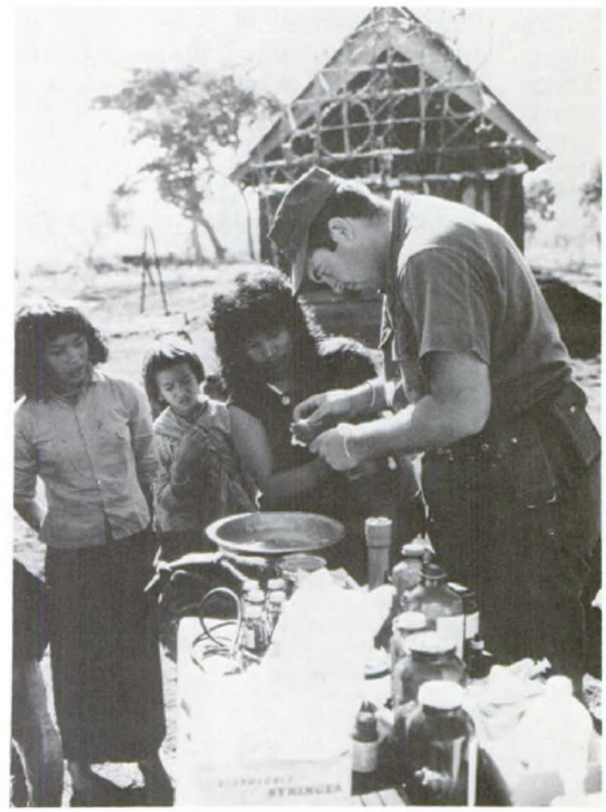

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Figure 1-3.—A SEABEE-attached Navy Corpsman administering treatment to a Vietnamese child held by his mother while other villagers look on.

The total strength of the SEABEES ebbs and rises with the world situation, as dictated by military commitments abroad. As our commitments decrease, so does the number of SEABEES (along with the rest of the Armed Services.) Naturally, those selected to remain must be of the highest calibre, dedicated, and highly motivated. This may be a disappointment to the mediocre, but it is a welcomed period of evolution to the "squared-away" SEABEE careerists. They realize that only in this manner can they maintain the quality of personnel needed to carry on this established tradition. The younger generation of SEABEES, of which you will become a part, are our greatest hope. You are the ones who will carry on with this tradition and will add your own glorious history to it.

THE NAVAL CONSTRUCTION FORCE

The Naval Construction Force (NCF) is an integral commissioned unit of the Naval Operating Forces, and as such, is under the control of the Chief of Naval Operations (CNO). The CNO commissions naval construction units, assigns them to the fleet, and approves the deployment of individual units. CNO also defines general mission, approves allowance lists, and approves the establishment of detachments.

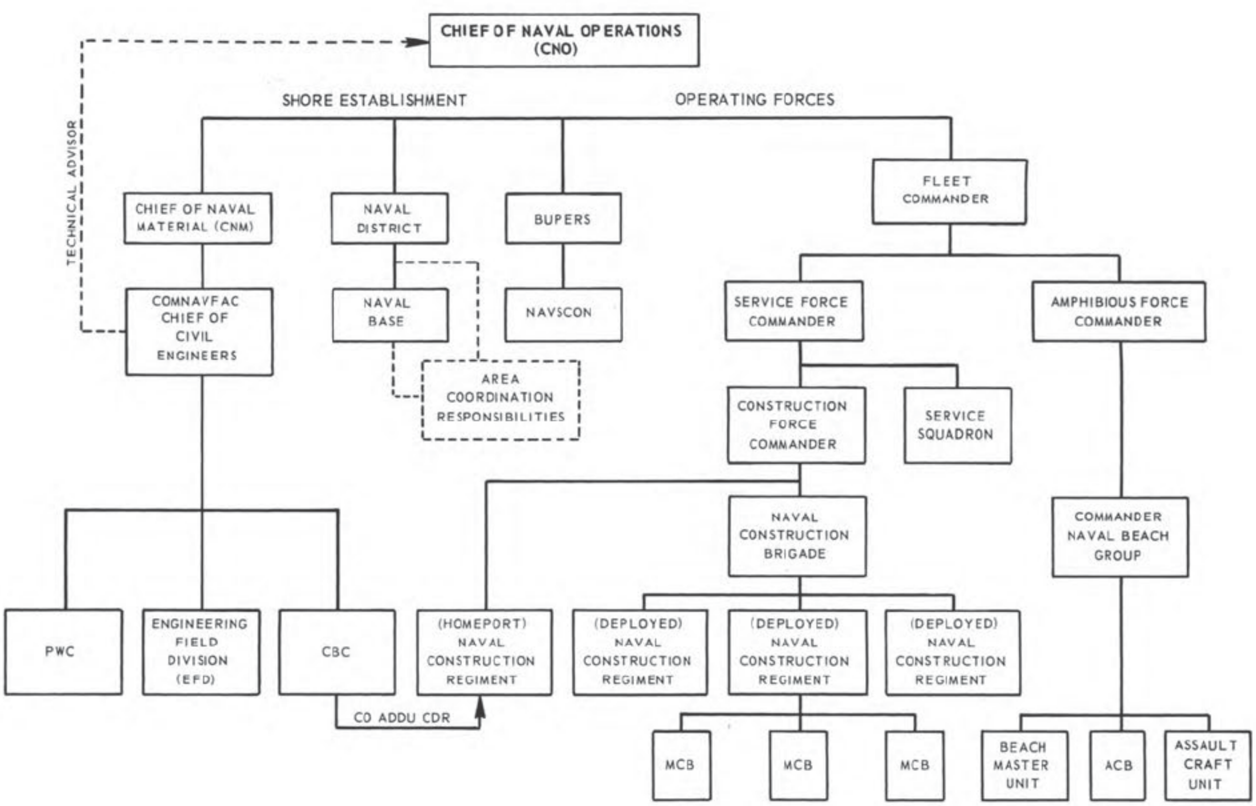
The Commanders in Chief of the Atlantic and Pacific Fleets are charged with ensuring that routing deployment schedules and assigned projects are in consonance with CNO policies. They exercise both operational control and administrative control of the assigned units of the NCF.

Due to the variety of unit organizations and chains-of-command inherent within the NCF, it is impossible to show on one organizational chart all their individual relationships. A chart which nearly approaches these relationships is shown in figure 1-4. This chart is presented here only to show you how some of the major SEABEE units tie-in to the naval organizational structure. Let us briefly review the organization of the entire naval establishment.

THE DEPARTMENT OF THE NAVY

The Department of the Navy consists of the entire naval establishment—the active and reserve forces—including all Marine Corps and Navy personnel, Coast Guard personnel when in service under the Navy, and Navy civilian employees.

The Department of the Navy is separately organized under the Secretary of the Navy. It operates under the authority, direction, and control of the Secretary of Defense.



29.1
Figure 1-4.—Chain of administrative control of the SEABEES.

Secretary of the Navy

The Secretary of the Navy (SECNAV) is a civilian administrator appointed by the President and approved by the Senate. He has direct policy control over the Department of the Navy (fig. 1-5), and is responsible for its efficiency and administration. He also has responsibility for the Navy's relations with other Government departments and with the public, and for the morale and welfare of naval personnel.

Chief of Naval Operations

The Chief of Naval Operations (CNO), a four star admiral, is the professional head of the Navy. As CNO, he is automatically a member of the Joint Chiefs of Staff, and is the principal naval advisor to the President, the Secretary of Defense, and the Secretary of the Navy. Under SECNAV, the CNO is responsible for command of the Operating Forces of the Navy and, except for those areas wherein the responsibility rests with the Commandant of the Marine Corps (CMC), exercises overall authority throughout the Department of the Navy in matters essential to naval administration such as security, intelligence, discipline, communications, and matters related to the customs and traditions of the Navy.

Chief of Naval Material

The Chief of Naval Material (CNM) is responsible for meeting the material support needs of the Operating Forces of the Navy, including those of the Marine Corps and other supporting organizations. He is responsible directly to the CNO and CMC in providing their respective services with equipment, weapons or weapons systems, materials, supplies, facilities, maintenance, and supporting services. To accomplish this mission he is assisted by the six SYSTEMS COMMANDS, one of which is the Naval Facilities Engineering Command.

The Naval Facilities Engineering Command (NAVFAC) is responsible for the design, planning, construction, and maintenance of all public works and public utilities of shore activities within the Navy. In addition, the Commander, Naval Facilities Engineering Command, who is also the Chief of Civil Engineers, is responsible to CNO for planning and programming manpower, material, and training related to naval combat construction forces (e.g. SEABEES). It is important to note that NAVFAC has no direct operational control over SEABEES; that responsibility is assigned only to the Chief of Naval Operations. However, once a construction operation is planned, NAVFAC advises CNO on the technical aspects of the project.

The Chief of Naval Personnel

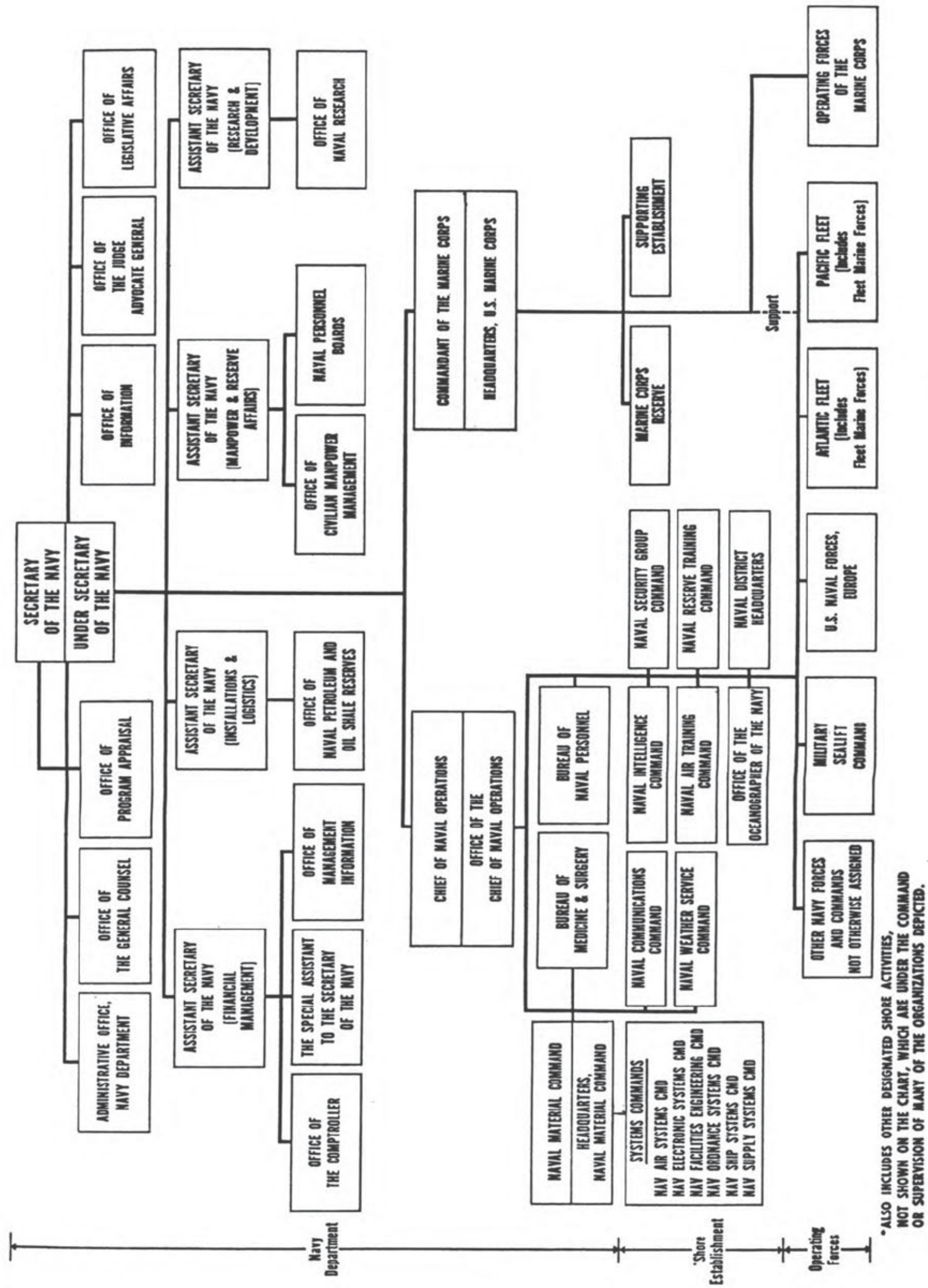
The Chief of Naval Personnel directs the Bureau of Naval Personnel (BUPERS). The mission of BUPERS is to plan and direct the procurement, distribution, administration, career motivation, education, and training of Navy personnel, including those of the Naval Reserve, as determined by the CNO. In this respect, BUPERS maintains service records on all active and reserve personnel, and it supervises the welfare, promotion, discipline, discharge, and retirement of all persons in the Navy.

The Chief, Bureau of Medicine and Surgery

The Bureau of Medicine and Surgery (BUMED) is responsible for safeguarding the health of Navy and Marine Corps personnel and for providing care and treatment for sick and injured members (including dependents). BUMED devises standards of sanitation and hygiene in the naval service; procures medical and dental supplies; and provides for the medical training of Navy doctors, nurses, and Hospital Corpsmen (HMs). It operates the Navy's hospitals, dispensaries, and medical schools for officers and enlisted men, and it conducts medical and dental research into matters of interest to the service.

The Operating Forces of the Navy

The Operating Forces of the Navy include the office of the CNO, the several fleets and seagoing forces, sea frontier forces, naval district forces, Military Sealift Command (formerly the Military Sea Transportation Service), Fleet Marine Forces, and such other naval shore (field) activities and commands as assigned by the Secretary of the Navy. The mission of the Operating Forces of the Navy, through use of its combat elements, is to seek out and destroy enemy naval forces, suppress enemy sea commerce, gain and maintain general naval supremacy, control and protect vital sea areas and lines of communication, and establish and maintain local superiority (including air) in areas of naval operations. In addition, these combat forces must seize and defend advanced naval



16.2

Figure 1-5.—Department of the Navy organization chart.

bases and conduct such land and air operations, including construction, as may be essential to the prosecution of a naval campaign.

Fleet, Force, and Type Commands

Fleet, as used in the Navy, has two meanings. As a major command it means, for example, the Atlantic Fleet or the Pacific Fleet. The Commander in Chief, U. S. Pacific Fleet (CINPACFLT), however, may have several operational fleets under his command, and it is this type of fleet we are concerned with.

A FLEET is an organization of ships, aircraft, marine forces, construction forces, and shore-based fleet installations. A fleet includes everything from carriers to submarines, supply ships, small craft, and even shore-based administrative offices and fleet training centers.

A FORCE is a major subdivision of a fleet; also, a smaller and more specialized group of ships. To form a force, a certain number of ships are selected for a desired mission. For example, a number of supply ships and tankers from a service force. A number of transports, cargo ships, landing ships, and supporting units (Amphibious Construction Battalions, for example) form an amphibious force.

A TYPE COMMAND is an administrative subdivision of a fleet or force into ships or units of the same type. The administrative head of such a group is known as a TYPE COMMANDER. Even though a bit confusing, all type commanders incorporate the term "Force" in their official title; for example, Service Force and Amphibious Force are both type commands. Respectively, the type commanders are called Commander, Service Force Atlantic/Pacific (COMSERVLANT/PAC) and Commander, Amphibious Force Atlantic/Pacific (COMPHIBLANT/PAC). Incidentally, all Naval Mobile Construction Battalions (NMCBs) and Amphibious Construction Battalions (ACBs) are under the administrative control of these two type commanders (refer back to fig. 1-4).

SEABEE CONSTRUCTION UNITS

The term SEABEE CONSTRUCTION UNIT, as used in this text, means a unit which has either a Commanding Officer or Officer-in-Charge of the Civil Engineer Corps; also, it is comprised mainly of the Construction (Group VIII) ratings and it is a unit which has a primary mission of construction in advanced areas, rather than one of supporting this construction.

In wartime, a major function of these construction units is to support Naval Task Forces (several Forces with a singular mission) and the Fleet Marine Forces (FMFs), with emphasis on complete readiness for any contingency. They play a vital role in the assembly and maintenance of naval floating drydocks and other floating equipment. Their principal function, however, usually involves advanced base construction, including advanced bases and airfields of semi-permanent nature for use of the FMF, both ground and air. SEABEE construction units also provide training for naval reservists, recruits, and other trainees, including such construction, maintenance, and operation as may be appropriate. Among other basic wartime functions, they may perform construction involved with the development and exploitation of natural resources in advanced areas.

During peacetime, construction units perform construction primarily at overseas bases, but also within the continental United States (CONUS), where the nature of such work necessitates security that could not otherwise be assured. SEABEES are also permitted to work within CONUS on projects related directly to training or morale, such as crew training projects or construction of recreational facilities. Another function during peacetime involves construction, rehabilitation, repair and maintenance of public works and public utilities at shore activities, where it is impractical or uneconomical to employ civilian labor or where the existing labor force is temporarily inadequate. Don't confuse this with duty at a Public Works Center (covered later).

The Naval Construction Force has two basic operating units: (1) the Amphibious Construction Battalion, and (2) the Naval Mobile Construction Battalion. Other construction units discussed in this chapter will be the Construction Battalion Maintenance Unit, Construction Battalion Unit, SEABEE Teams, and Underwater Construction Teams.

The Amphibious Construction Battalion (ACB)

The Amphibious Construction Battalion is a commissioned naval unit whose function is to provide military and amphibious construction support to Naval, Marine, and other Forces in military operations. In addition to providing methods for troop and equipment movement from ship-to-shore (fig. 1-6) the ACB may install and operate tanker-to-shore bulk fuel delivery

3.85
Figure 1-6.—ACB-2 SEABEES moving supplies and equipment.

systems, develop and improve beach facilities, and undertake special construction projects, especially those requiring surf, open sea, and heavy rigging experience, including work with pontoons and other floating equipment. In some instances, there may be UDT (Underwater Demolition Team) personnel working with these units for removal of underwater obstacles which may jeopardize landing operations. UDT members receive extensive training in this type of work, and the teams are comprised of various ratings, including SEABEES.

The ACB is organized administratively into a headquarters company, an equipment company, two pontoon companies, and a single construction company. It has a wartime complement of 31 officers and 638 men, which includes 14 CEC officers and 220 Construction (Group VIII) ratings. The size and composition of an ACB is based on providing support for an infantry landing. The ACB is not intended for prolonged use in the field; and its work is finished when the landing is accomplished.

At present, there are two ACBs: (1) Amphibious Construction Battalion ONE, operating from Coronado, California, and (2) Amphibious Construction Battalion TWO, operating from Little Creek, Virginia. Your chances of assignment to an ACB is relatively small.

The Naval Beach Group is an administrative organization of the Amphibious Force, organized and equipped to provide support to a reinforced division during an assault landing. The group is composed of a commander, his staff, the ACB, a Beachmaster Unit, and an Assault Craft Unit. The Commander, Naval Beach Group receives direction from and reports to his respective Force commander, either COMPHIBPAC or COMPHIBLANT.

The Naval Mobile Construction Battalion (NMCB)

The Naval Mobile Construction Battalion is designed for dual military/construction support operations to build advanced base facilities in

support of United States and Allied military forces, primarily the Marine Expeditionary Forces.

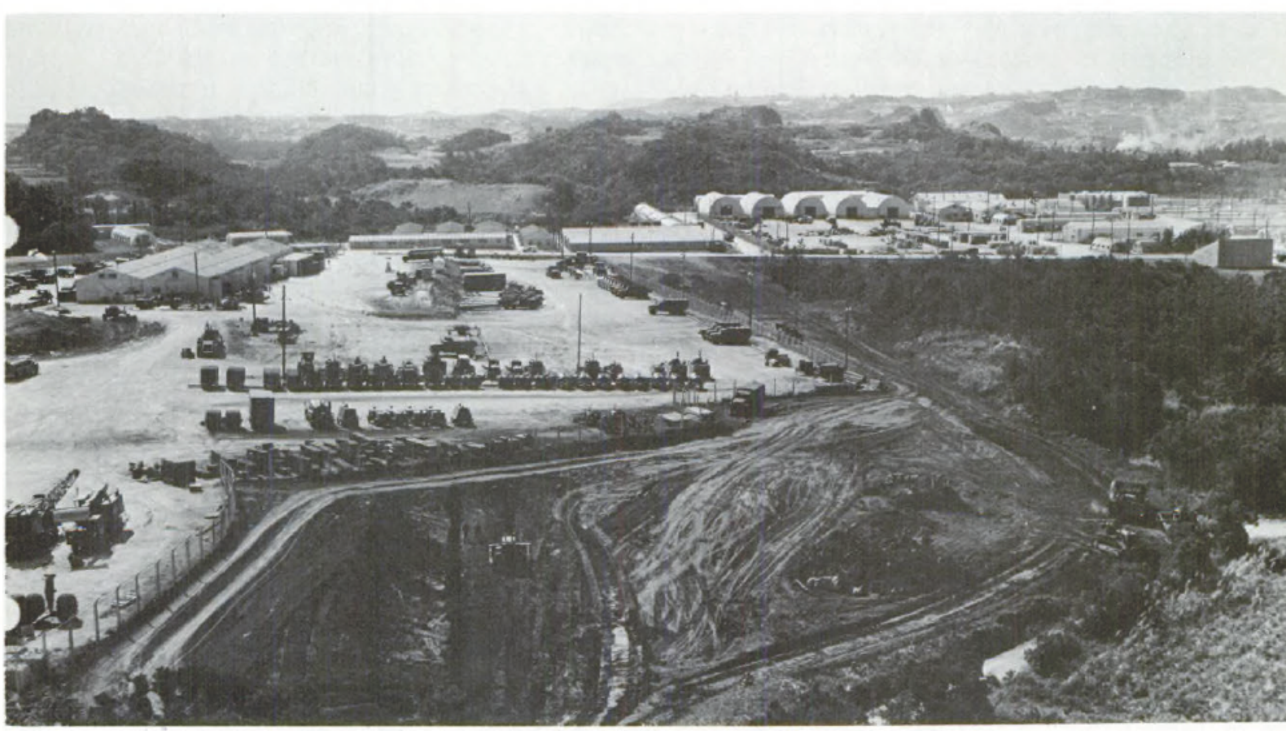
The NMCB is capable of performing earth-moving, weight-lifting, quarrying, equipment repair, reinforced concrete construction, structural steel fabrication and erection, installation and operation of electrical and plumbing systems, carpentry, and surveying.

Figures 1-7 through 1-16 are shown to give you an idea of the various jobs of an NMCB and the working conditions the men go through during a deployment. These illustrations are in addition to those shown in various chapters of this training manual.

A typical NMCB organization chart is shown in figure 1-17. As you can see, the NMCB is organized to be self-sufficient, and when deployed, it is equipped to operate independently for a period of 90 days, should the need arise.

The NMCB is usually commanded by a Commander, CEC, who has extensive experience in construction and personnel administration. He is assisted by numerous staff officers and company commanders. All company commanders are CEC officers, usually with a degree in engineering. Exceptions are limited duty officer (LDOs) and warrant officers (WOs or CWOs) who came up through the ranks. These officers compensate for their lack of an engineering degree or college education with years of actual construction and administrative experience. Most were E-6 or above when they accepted their commissions. Some members of the staff are not CEC officers; these are the medical and dental officers, the supply officer, and the chaplain. Occasionally, line officers are assigned to a battalion, and they normally would direct the Administrative and Personnel Department. A typical NMCB formation during a command ceremony at an overseas deployment is shown in figure 1-18. Personnel are shown in battalion formation, in their respective companies and in their regular working uniforms.

The basic allowance of an NMCB, as currently established by CNO, is 21 officers and 563 men. During special wartime operations, such as in Vietnam, this allowance may be increased to



29.391

Figure 1-7. — It takes hundreds of vehicles and pieces of equipment to do the job of a Construction Unit. Here are just a few of those belonging to NMCB-3 when deployed at Camp Kinser, Okinawa.

29.392
Figure 1-8. — A SEABEE sentry manning his bunker as part of an NMCB's perimeter defenses.

24 officers and 739 men. This additional allowance provides for a greater horizontal construction capability, and it consists primarily of Equipment Operators and Construction Mechanics. It also includes several non-rated men for camp security.

The NMCB is not composed entirely of Construction (Group VIII) ratings; for example, only 470 of the basic 563 billets are Group VIII ratings. The remaining men are support personnel, such as the Storekeepers, Commissarymen, Yeomen, and Gunner's Mates. Included, is one billet for a Marine Gunnery Sergeant (G/SGT). He is the principal advisor to the Commanding Officer (CO) and to the S-2 (Plans and Training Officer) on matters related to camp security, combat intelligence, military training, and combat readiness.

Due to the great variety of construction missions, localities, and conditions under which the SEABEES operate, the battalion organization has, for the most part, been left up to the CO. This flexibility permits the best use of men and equipment for each deployment. However, the Naval Facilities Engineering Command has published organizational guides; and these, plus the experience of individual officers and men, form the basis of the battalion organization.

In this battalion organization, every subdivision (usually company) has a construction/combat assignment and every officer and man fills a construction/combat billet. Whenever possible, command channels are identical from top to bottom for construction and combat. Most exceptions are among the support ratings in Headquarters Company.

BRAVO Company (fig. 1-19) is a typical company organization. It is important to note that the construction organization is also the combat organization. The NMCB combat organization is discussed in detail in the SEABEE Combat Handbook. If you are interested in more details on individual assignments, ask your leading petty officer.

Control and Command of the NMCBs

Control of the Naval Mobile Construction Battalions (NMCBs), as with other units, falls into three categories: (1) administrative control, (2) operational control, and (3) technical control.

ADMINISTRATIVE CONTROL is the direction or exercise of authority over subordinate organizations pertaining to personnel management, supply services, and other matters not included in the operational mission.

29.34
Figure 1-9.—Heavy rains during monsoon season caused severe washout problem in road projects in South Vietnam. Here, a SEABEE jeep works its way through the condition during an inspection to survey the extent of damage.

29.241
Figure 1-10.—SEABEE surveyors at work.

29.62
Figure 1-11.—An EO of NMCB-121 operates a bulldozer towing a sheepsfoot as he works on Route ONE Road Project in northern part of South Vietnam.

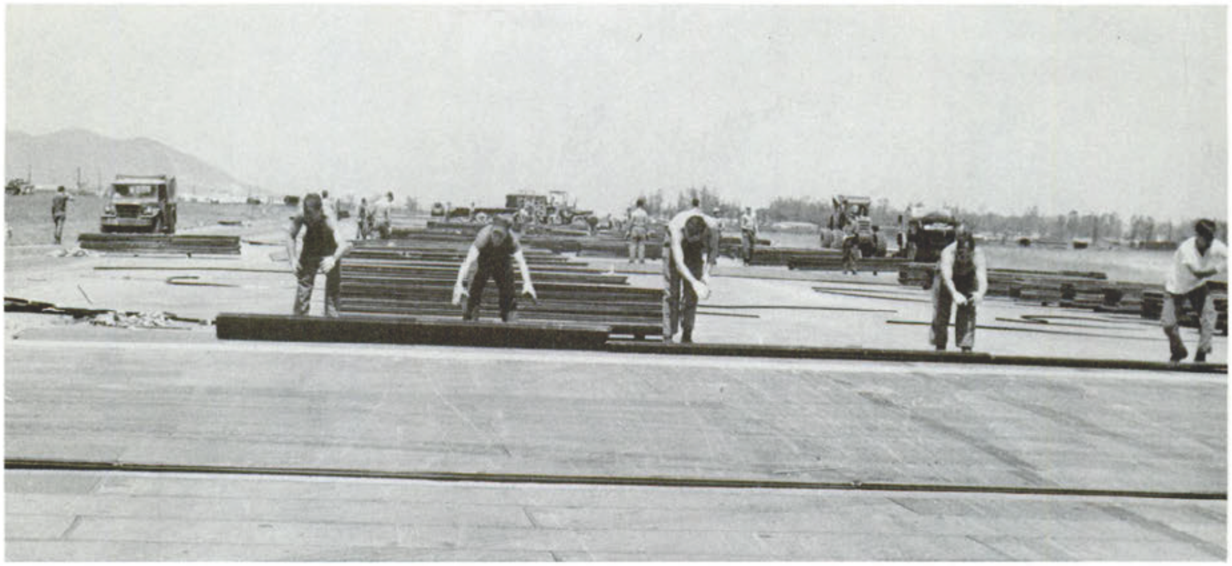


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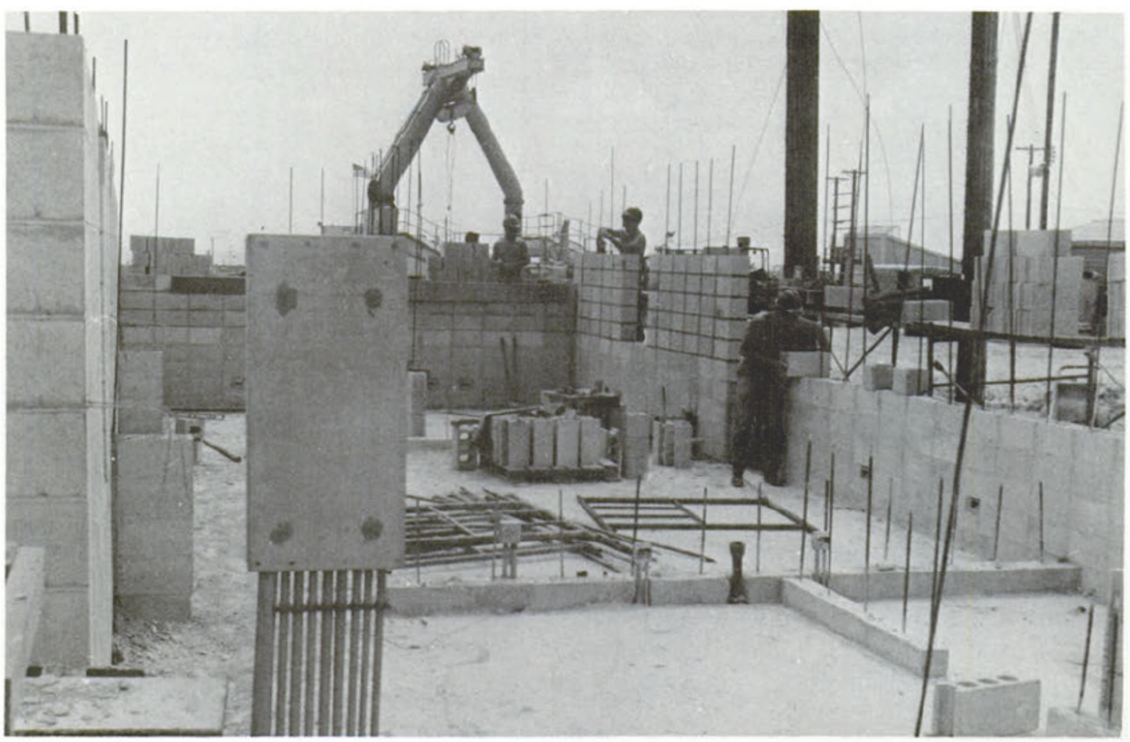
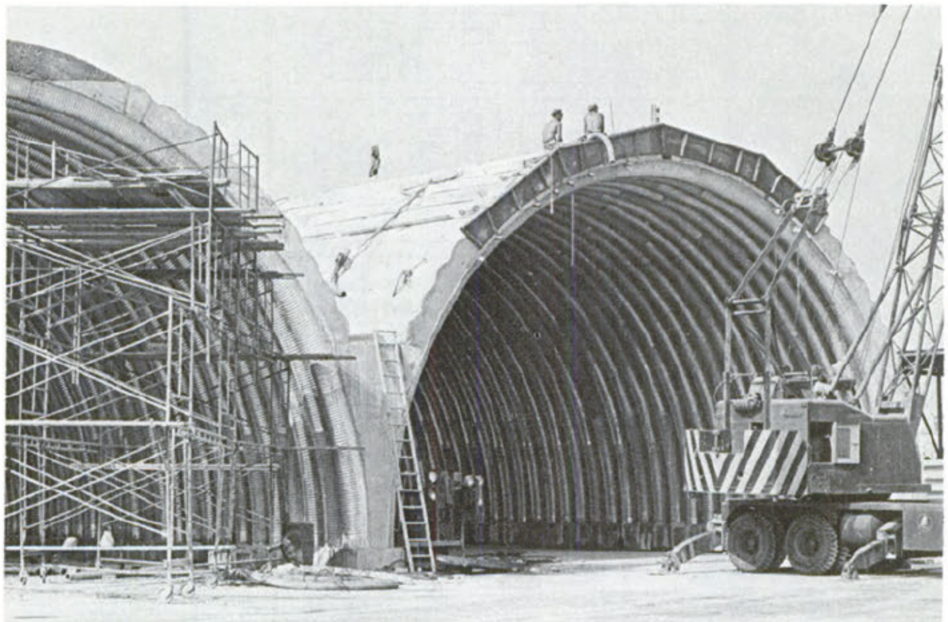
Figure 1-12.—SEABEES laying a Short Airfield for Tactical Support (SATS).



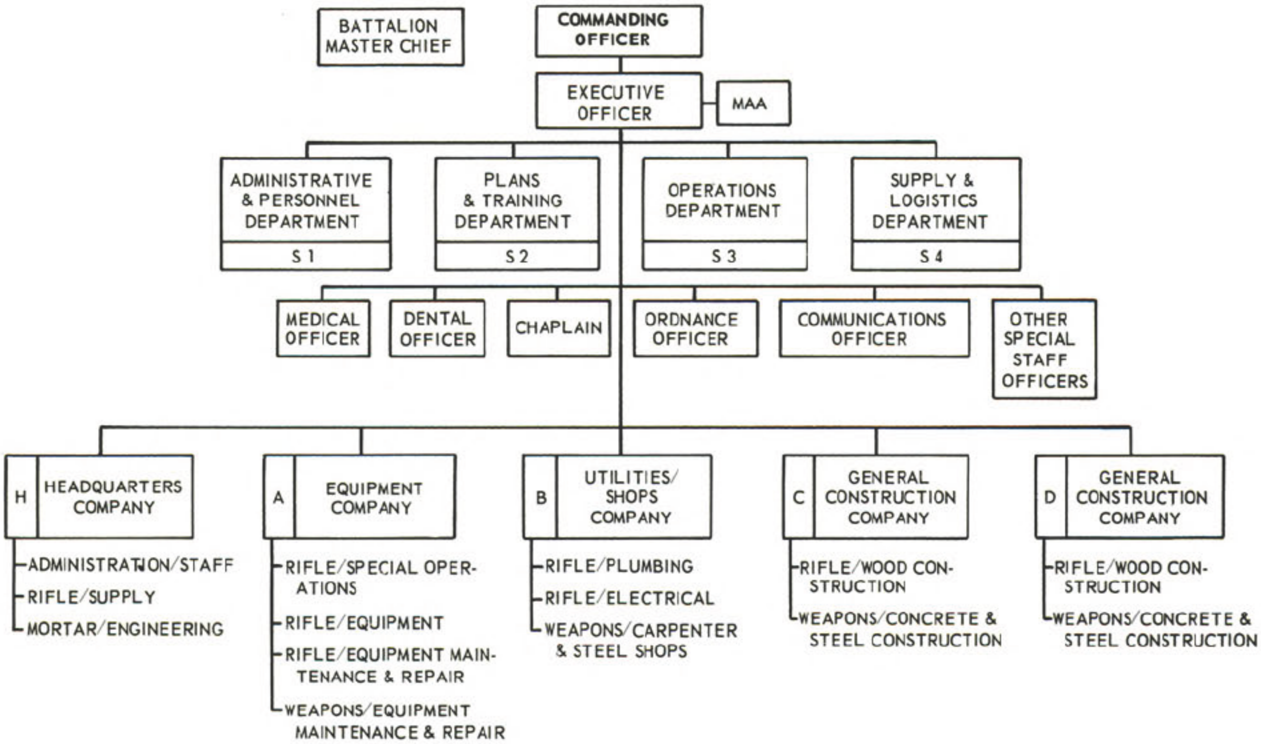
29.394
Figure 1-13.—Builders of NMCB-3 laying concrete blocks for an Admin building project at White Beach, Okinawa.



29.395
Figure 1-14.—Progress on "Concrete Sky" construction.

29.396
Figure 1-15.—SEABEES driving piles for a bridge construction in South Vietnam.

29.397
Figure 1-16.—SEABEES repairing a railroad track.



2.223
Figure 1-17.—A typical NMCB organization chart.

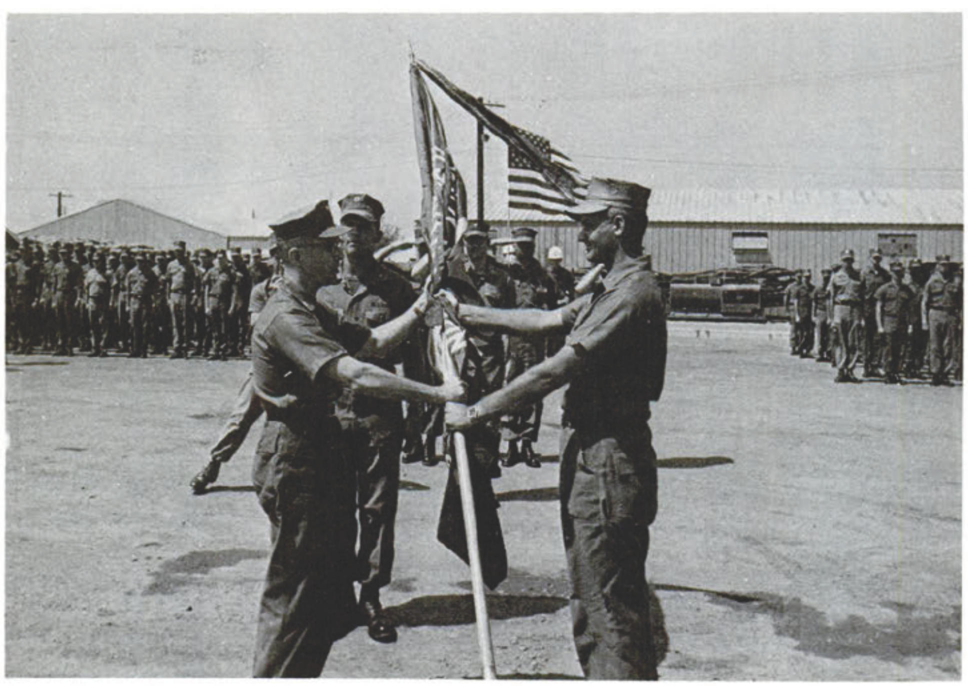


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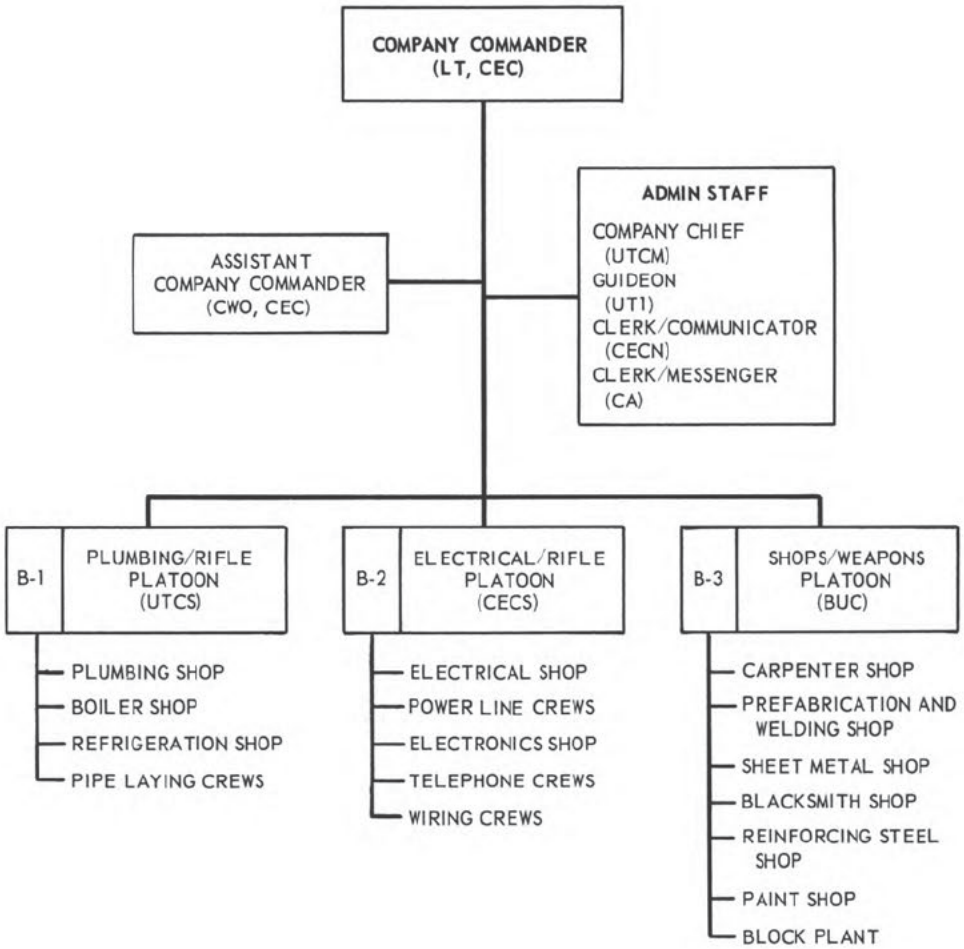
Figure 1-18.—A typical battalion formation during a change-of-command ceremony overseas.



2.223

Figure 1-19.—BRAVO Company organization (NMCB Utilities and Shops/Rifle Company).

The Commander-in-Chief of each Fleet exercises administrative control over all NMCBs (as well as ACBs) through an Administrative Type Commander. The Commander, Service Force controls all NMCBs, as well as other SEABEE construction units (except ACBs) within the Fleet. He in turn exercises this control through the Commander, Fleet Construction Force. As used herein, the term "Commander, Fleet Construction Force," applies to either the Commander, Naval Construction Battalions, U. S. Atlantic Fleet (COMCBLANT) or the Commander, Naval Construction Battalions, U. S. Pacific Fleet (COMCBPAC). There is no individual commander with the title "Commander, Fleet Construction Force."

When only one battalion is assigned to one area (as is often the case in peacetime), the CO of that NMCB reports directly to COMCBLANT or COMCBPAC. However, when several NMCBs are operating in one area, such as Vietnam, then the Commander, Fleet Construction Force will request from CNO that additional Naval Construction Regiments, and possibly Naval Construction Brigades, be established to assist in administration.

A NAVAL CONSTRUCTION REGIMENT (NCR) is established to administer more than one NMCB, particularly in wartime. In peacetime, the NCR is usually located at one of the Construction Battalion Centers in the States, such as the 31st NCR located at Port Hueneme, California. Most

NCRs are commanded by CEC Captains; and in a combat area, he would be designated "Commodore."

A NAVAL CONSTRUCTION BRIGADE (NCB) administers to more than one Naval Construction Regiment. These are normally commanded by a Rear Admiral, CEC.

OPERATIONAL CONTROL involves the assignment of tasks, designation of goals, and functional use of military units. It does not involve administration, discipline, internal organization, or unit training, except when a subordinate requests assistance. Operational control, administrative control, and command may be exercised by the same commander, or each must be exercised by a different commander.

NMCBs are classed as "fleet" units, although their operational mission is ashore. Thus, operational control of these units has two aspects: (a) control of movement, and (b) control of operations ashore.

The CONTROL OF MOVEMENT of all SEABEE construction units is controlled by CNO through the Fleet Commanders. An NMCB is never ordered to a different location without his express approval.

CONTROL OF OPERATIONS ASHORE is exercised by the Command so designated in the Construction Plan. This is usually the major command for which the construction work will be performed. Thus, operational control may be assigned to naval bases, naval stations, fleet activities, or higher commands. For example, a battalion on Guam would be under the operational control of the Commander, Naval Forces Marianas, and under the administrative control of COMCBPAC. As explained before, if the construction assignment required more than one battalion, direct operational control may be exercised through an NCR.

TECHNICAL CONTROL is the specialized or professional guidance and direction exercised by an authority of the Navy in technical matters. Each of the two Bureaus and six Systems Commands controls certain technical matters that affect an NMCB. NAVFAC, BUPERS, and the Naval Supply Systems Command (NAVSUP) will affect you most as a SEABEE.

NAVFAC, as we explained previously, exercises technical direction over such matters as organization, equipment, operational procedures, SEABEE training and personnel readiness, civil engineering standards and procedures, disaster control ashore, and others.

BUPERS exercises technical control over recruitment, training, and assignment of personnel; welfare and recreation; officers' messes; CPO messes; and transportation of Navy personnel and their dependents.

NAVSUP exercises technical control over purchasing and stocking functions and the general mess.

An NMCB is under the COMMAND of the naval base, advanced base, or other base at which it is stationed. While aboard ship, it is under the command of the Captain of the ship. When an NMCB, or one of its detachments, is installing facilities at an isolated location, it may come under the direct command of a Naval District Commandant or Area Commander.

SEABEE Teams

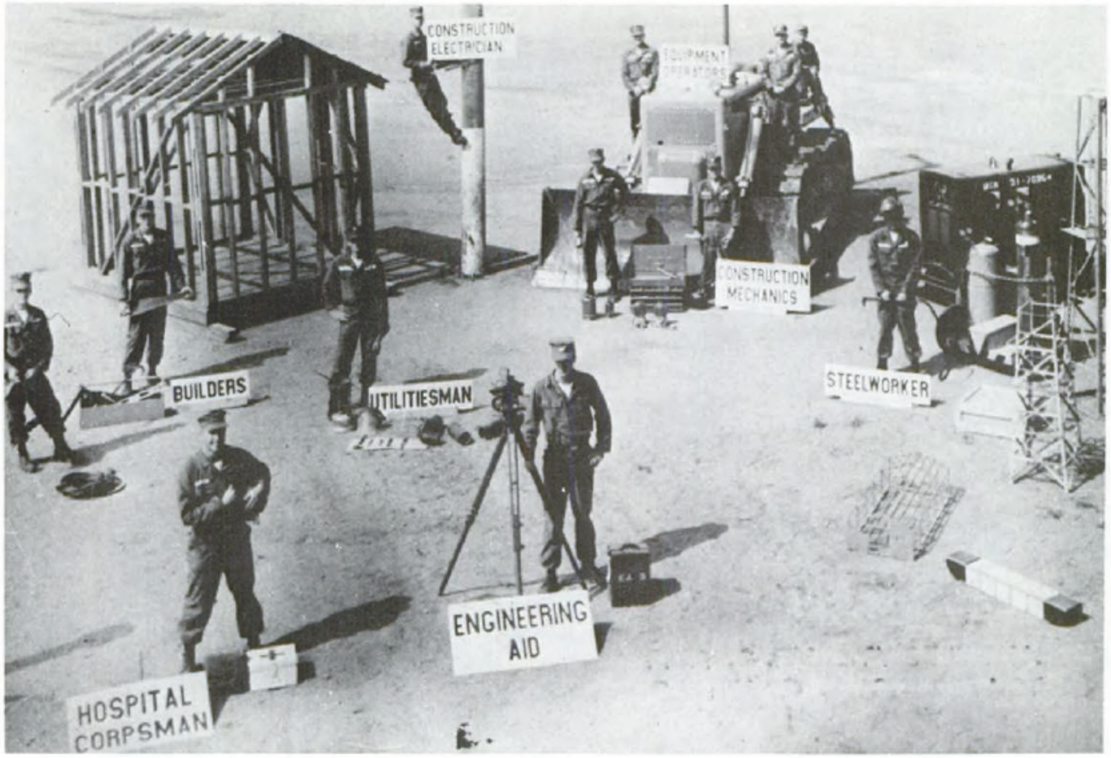
A SEABEE Team is a small, highly mobile, air transportable construction unit capable of providing disaster relief or technical assistance through teaching, supervising, and working with the local people in the area to which it is deployed.

Although SEABEE Team allowances are normally associated with an NMCB, the responsibility for a Team's operations in a foreign country lies with the respective United States Ambassador.

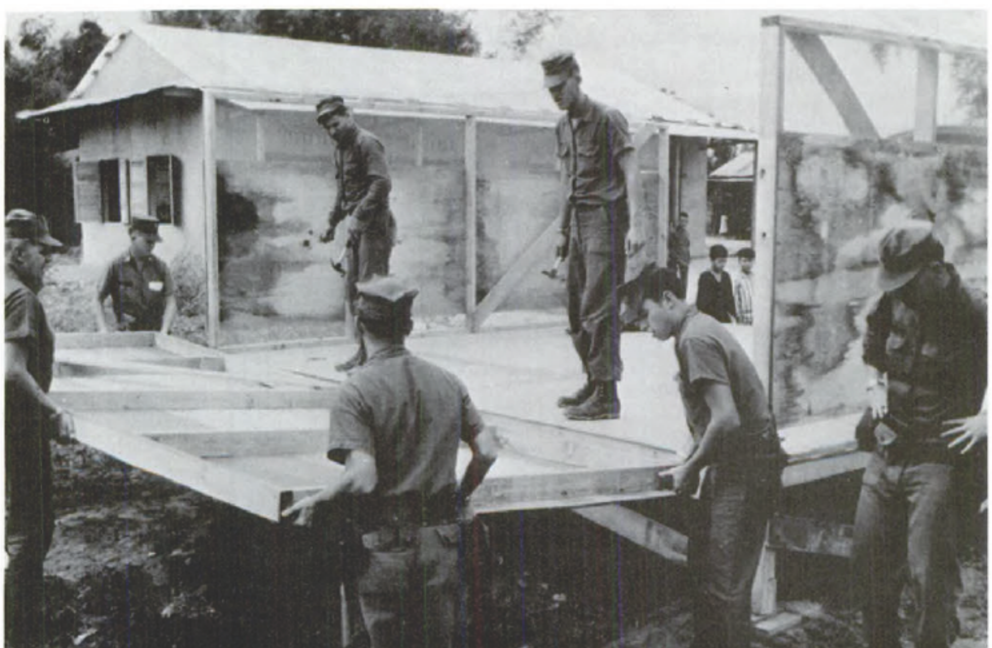
SEABEE Teams may be tailored to accomplish a variety of construction tasks. Officially, their allowance of one CEC officer and 12 petty officers represents either of two primary capabilities; a vertical construction capability, or a horizontal construction capability. A SEABEE Team with a primary capability of vertical construction would contain more Builders and less Equipment Operators and Construction Mechanics than the one shown in figure 1-20.

These teams receive extensive training at their parent NMCB's homeport. After completion of this rigorous training, they may deploy to any part of the world — generally to an underdeveloped area. These teams are actually the Navy's "Peace Corps" and their work in Vietnam has won the love and respect of these people. Figures 1-21 through 1-24 show some of the SEABEES' projects in support of civic action programs.

Each team carries enough housekeeping supplies, tool kits, and automotive and construction equipment to be self-sufficient in the field, while performing a variety of construction assignments. SEABEE Teams have been employed as engineers for the Army's Special Forces, as technical instructors for the Agency for International Development (AID), and as construction advisors under various military assistance programs.



29.399
Figure 1-20.—Capability of a 13-man SEABEE Team (officer not shown).



29.400
Figure 1-21.—A prefabricated building being assembled by a Medical Civic Action Program (MEDCAP) Team of NMCB-74. The building will be used to shelter SEABEE MEDCAP Teams and the villagers who come for treatment.

29.401
Figure 1-22.—SEABEES supervising local people—they are preparing a foundation for a school building under the Civic Action Team Program.

29.402
Figure 1-23.—SEABEE Team laying water supply line in an isolated village.

29.62
Figure 1-24.—A SEABEE training a Vietnamese to become an equipment operator.

Construction Battalion Maintenance Unit (CBMU)

The Construction Battalion Maintenance Unit is a commissioned unit which operates and maintains public works and public utilities at an advanced base after construction has been completed by an NMCB. Its functions resemble those of a Public Works Department at a naval activity. In the early phases of construction, it may be assigned to the Advanced Base Construction Force to help build the facilities it will later maintain. The CBMU is eventually transferred to the Naval Base Command. The CEC officer in charge often then becomes the Public Works Officer and his unit operates as a Public Works Department. Normally, CBMUs are commissioned only in wartime.

Construction Battalion Unit (CBU)

A Construction Battalion Unit may be commissioned by CNO to meet a specific requirement. The unit is organized and equipped to suit a special mission and does not have the flexibility of other SEABEE construction units. For years there had been only one CBU in commission—CBU-201 which is tasked with construction support of the Antarctic Research Program. However, in 1969, a second unit was commissioned. This unit is CBU-401, located at the Great Lakes Naval Training Command, Illinois.

The Navy has established a number of SEABEE Shore Units, consisting of 1 officer and 45 enlisted men, at naval activities throughout the continental United States. The Navy needs a capability to maintain the technical proficiency of SEABEES on shore duty in order to provide a nucleus of skilled military craftsmen to rapidly augment Naval Mobile Construction Battalions when necessary to support contingency operations. In addition, a SEABEE careerist should be provided the opportunity for at least two years of shore duty for every four years of Mobile Construction Battalion duty including overseas deployments. Currently, SEABEES are assigned to shore duty on an individual assignment basis. Some assignments make full use of the SEABEES' construction capabilities and foster skill improvement through on-the-job experience, e.g., provide a construction labor base where a civilian labor base does not exist, etc. However, many assignments do not provide the individual the opportunity to work in his construction skill specialty, and thus additional training is needed to maintain skills. These SEABEE Units will provide:

1. An emergency response capability (contingencies, disaster, emergencies)
2. Military unit training
3. Construction skill training
4. Meaningful shore duty

SEABEE Units will be in addition to the normal public works organization, not in replacement thereof. Competition with the civil service work force or civilian contractors is not desired nor contemplated. Only that construction will be done which is necessary to support the SEABEE Unit training mission and to provide meaningful experience for SEABEES. Construction work done as training will be accomplished at multiple naval activity geographic locations. There will be no civilian reductions in force or employment levels as a result of this program.

Underwater Construction Team (UCT)

Underwater Construction Teams are a new addition to the SEABEE community. These teams were organized to meet specific needs in support of research and operations involving underwater construction. UCT members must graduate from a Navy diving school. As qualified divers, they receive additional pay (diving pay), which ranges

from \$50 - \$105 per month, depending on the individual's pay grade.

SEABEES ON SHORE DUTY

After spending approximately three years with any of the previously discussed SEABEE construction units — all of which are considered SEA DUTY (except CBU ashore) — you will probably be eligible for SHORE DUTY. (NOTE: There are many requirements which must be met to become eligible for shore duty. It is not the intent here to cover these. For answers to specific questions on rotation, consult your personnel office.)

Types of Shore Duty

Primarily, SHORE DUTY is of two types: (1) overseas shore duty, and (2) CONUS (Stateside) shore duty.

In general, OVERSEAS SHORE DUTY is an assignment to a shore activity outside the continental limits of the United States. In almost all cases, this type of duty is considered as sea duty. A few exceptions are: Hawaii, Alaska, and certain assignments in Japan and Europe. These special assignments, and others, are classified as PREFERRED SEA DUTY and they are actually counted as CONUS shore duty.

Generally speaking, all duty within the continental United States (CONUS) is considered as CONUS SHORE DUTY. (Again, there are exceptions.) Very roughly, the average SEABEE can expect assignments of sea duty, overseas shore duty, and CONUS shore duty during his 20-year career, but not necessarily in that order.

As a CA or CN, your first duty assignment will most likely be sea duty, probably in a Naval Mobile Construction Battalion. If you attend an "A" school first, this time will count as part of your sea duty tour. Very few non-rated men have an opportunity to go to the various shore activities described below. Consider yourself fortunate if you are chosen.

SEABEE Shore Activities

The major shore activities, principally staffed with SEABEES, are the Construction Battalion Centers and the Public Works Centers. Other assignments may include Naval Schools, Construction (NAVSCON), Naval Training Commands, recruiting stations, and many others. With space being limited, we cannot cover every activity within the Navy of vital concern, either directly or indirectly, to the SEABEES. The fact that an activity is not included here, therefore, does not in any way diminish its importance.

THE RESERVE SEABEE

Reserve SEABEES are assigned to units of either the Combat Unit Component or Training and Support Component.

The Reserve Naval Construction Force Combat Unit Component consists of the Reserve First Naval Construction Brigade; the Brigade Staff; and nine Reserve Naval Construction Regiments, each composed of Reserve Mobile Construction Battalions. These Reserve Battalions consist of sub-units, with officers and enlisted men located at various Naval Reserve Training Centers throughout the United States.

Officers and enlisted personnel assigned to these units are trained as a unit. Annual active duty for training is performed as a unit to perfect the team abilities of personnel assigned to the Brigade Staff, nine regiments, and 18 battalions.

The battalion sub-units provide the recruiting source for manpower and also a proper mix of military and professional training to enable the enlisted men to perform their skills as teams in the battalion. The battalions drill as a battalion once per quarter to maintain the readiness posture. The balance of the drills are, in general, scheduled for sub-unit drills at Reserve Training Centers.

Reserve CEC officers and Group VIII personnel who are not assigned to one of the above Combat Unit Component activities are assigned to units of the Training and Support Component. These officers and men are assigned to mobilization billets other than activities of the Combat Unit Component. They train to develop individual professional and military skills, since their mobilization assignment would be to an activity other than the Combat Unit Component. Drilling on an annual required drill schedule, these individuals perform their annual active duty for training in the assigned mobilization billets.

The SEABEE reservist should read pertinent Navy publications in order to keep informed on changes occurring within the Navy. One, written expressly for his benefit, is the Naval Reservist, NavPers 15653. Others are: The U.S. Naval Training Bulletin, NavPers 14900 (published quarterly); All Hands; the Bureau of Naval Personnel Information Career Bulletin, NavPers-0; and the Navy Civil Engineer, which

is intended for information of Regular and Reserve personnel of the Civil Engineer Corps and the SEABEES.

RATING STRUCTURE

The training mission of the peacetime Navy is to produce broadly qualified versatile personnel who, particularly in time of emergency, can be advanced to positions of greater responsibility and authority. If this mission is to be accomplished, several jobs have to be performed. These jobs have been classified in accordance with the RATING STRUCTURE.

In order to understand the rating structure, which provides for the Navy's needs under both peacetime and wartime conditions, you must understand the difference between a RATING and a RATE.

An occupational group of jobs requiring similar interests, training, experience, knowledge, and skills is known as a RATING. For instance, in the SEABEES, the tasks of surveying, material testing, and drafting are grouped under one rating—the Engineering Aid.

Within every rating are steps for advancement, and with each step there is an increase in pay. These steps, or pay grades, are the RATES within the rating. The rating in this illustrative case is Engineering Aid, abbreviated EA. The rates are Engineering Aid Third (EA3), Engineering Aid Second (EA2), Engineering Aid First (EA1), Engineering Aid Chief (EAC), Senior Chief Engineering Aid (EACS), and Master Chief Constructionman (CUCM). Perhaps you will wonder why at the Master Chief (E-9) level this rate becomes CUCM instead of EACM; well, they call this change a COMPRESSION in the rating structure. The SEABEE rating compression (E-9 level) will be explained later in this chapter.

Constructionman (CN), Constructionman Apprentice (CA), and Constructionman Recruit (CR) are also rates because they represent pay grade levels within occupational areas—the Construction (Group VIII) ratings in this case.

GENERAL AND SERVICE RATINGS

The two main types of ratings in the present enlisted rating structure are general ratings and service ratings.

GENERAL RATINGS identify broad occupational fields of related duties and functions. Some general ratings include service ratings; others do not. Both Regular Navy and Naval Reserve personnel may hold general ratings.

SERVICE RATINGS identify subdivisions or specialties within a general rating. Although service ratings can exist at any petty officer level, they are most common at the PO3 and PO2 levels. Both Regular Navy and Naval Reserve personnel may hold service ratings.

At present, there are no service ratings in the Construction rating structure. ALL SEABEE ratings are classified as general ratings.

The identification of a particular specialty in the SEABEES is indicated by an NEC (Navy Enlisted Classification Code) number. Generally, NECs are assigned only to those at E-5 level and above, who are graduates of an applicable course of instruction. However, if qualified, an E-4 may be given an NEC when granted a "waiver" by BuPers. You will learn more about NECs as you advance in rate.

CONSTRUCTION (GROUP VIII) RATINGS

Presently, there are 12 groups in the rating structure of the Navy; one of them is the Construction rating group—simply referred to as GROUP VIII ratings. Being a SEABEE, you will study the skills of one of the Group VIII ratings.

The path of advancement for apprenticeship in each rating group is shown in figure 1-25. Study this figure carefully for a better understanding of the path of advancement (below E-3 level) of the various rating groups.

The Group VIII ratings include seven ratings. Our previous example, the Engineering Aid, is one of them. The following sections in our discussion will introduce you to some of the main functions of each of the ratings in the Construction group. Although Constructionman is not a rating, it is included in this section to give you a highlight of the major functions that you may be required to perform. You will, of course, have a better understanding of the overall scope of duties of the Group VIII ratings after studying this training manual.

Constructionman (CN)

The path of advancement for a recruit in the SEABEES is to become a Constructionman Recruit (CR), then a Constructionman Apprentice (CA), and then a Constructionman (CN). From CN, he may "strike for" any of the ratings in the Construction group.

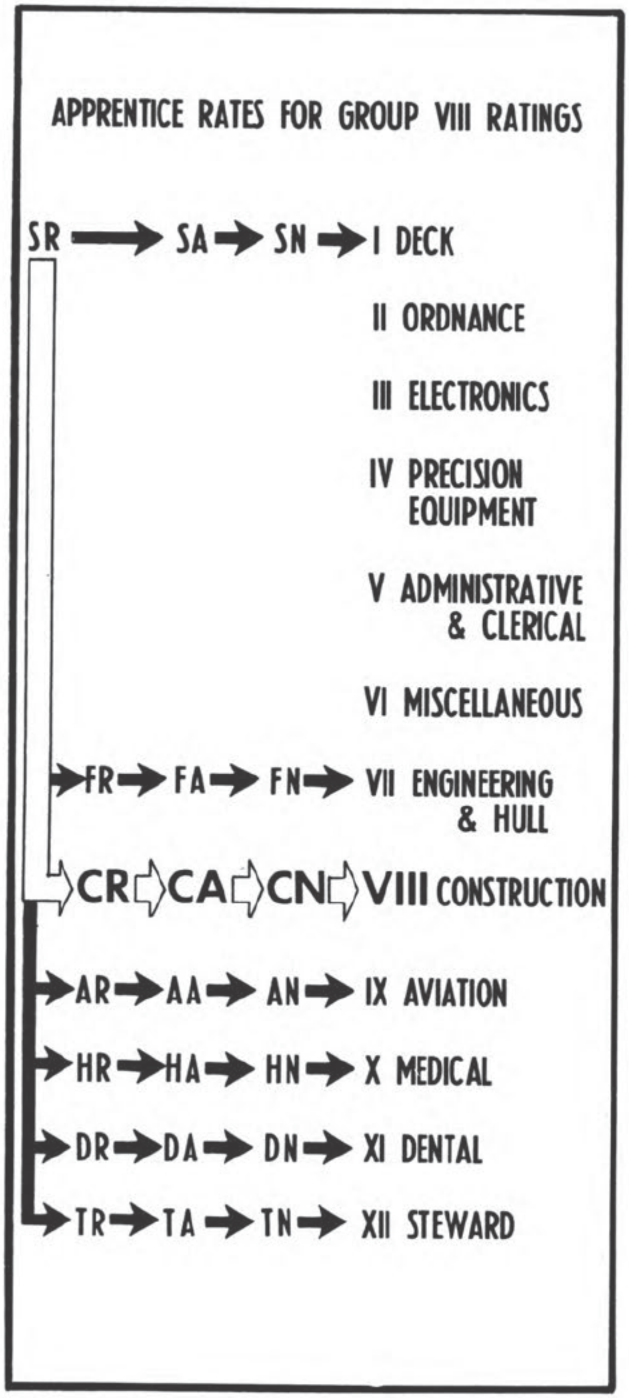


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Figure 1-25.—Path of advancement for apprenticeship in each rating group.

A Constructionman performs routine or nonskilled duties in various SEABEE operations. If he is a graduate of a Class A school or if he has passed the examination for third-class petty officer, but was not promoted because of quota limitations, he may be designated as a striker in the rating that he went up for. As a CN, you are expected to perform the following:

1. Select proper handtools to perform common and elementary tasks in carpentry, plumbing, rigging, automotive repair, electrical wiring, etc.
2. Draw and read simple diagrams and sketches used in construction work.
3. Serve as chainman in a survey party, using chaining pins, tapes, plumb bob and range poles; and perform other duties as directed by the chief of the party.
4. Operate passenger vehicles and light trucks and perform minor maintenance on them, including such tasks as adding gasoline, oil, and water; changing and repairing tires; taking specific gravity readings of battery electrolyte; and changing lamps and lamp fuses.

In addition to the above, the CN is expected to meet the following requirements:

1. Know the safety precautions applicable to various working conditions, such as in driving motor vehicles; working around quarries; earthmoving and paving operations; shop work; painting or preservation tasks; and handling of flammable materials, firearms, and ammunition.
2. Have sufficient knowledge of mathematics to add, subtract, multiply, and divide whole numbers, fractions, and decimals.
3. Understand the basic SEABEE unit organization and mission—particularly the NMCB.
4. State the various duties of each of the Group VIII ratings.

Builder (BU)

Builders in the SEABEES are qualified to do almost any kind of construction with wood or concrete. They build warehouses, hospitals, barracks, wharves, or almost anything else that you have seen around a naval base. They have to be carpenters, masons, and painters. They must know the meanings of construction lines and symbols used on drawings. You will see Builders at work on such jobs as operating carpenter shops, placing concrete, and erecting wooden or concrete structures. One of the more

common jobs of Builders (along with the Steelworkers) is the erection of rigid-frame buildings, both stateside and overseas.

Construction Electrician (CE)

Construction Electricians work on various types of electrical installations. Their duties involve the installation, operation, maintenance and repair of generators, transformers, motors, lighting fixtures, and so on. They also work aloft and aground on electrical distribution systems. In setting up a distribution system, the Construction Electrician erects poles, attaches insulators, strings wires, lays cable, and installs transformers on poles.

Other duties performed by Construction Electricians include the installation, operation, maintenance and repair of telephone systems, public address systems, and inter-office communication systems. They string telephone lines, install and operate telephone switchboards, install bell and buzzer circuits, and splice telephone cable.

Construction Mechanic (CM)

Construction Mechanics are the "fixer-uppers" for the Construction Battalion. Anything that the Equipment Operator can drive, the Construction Mechanic can fix. Construction Mechanics work on both gasoline and diesel engines. They are expected to know how to use handtools and power tools, measuring instruments, gages, thermometers, and pressure indicators. They must know tires, lubrication, and batteries, and they are required to maintain, repair, and replace parts, and to overhaul any kind of engine used by the Construction Battalion. Some knowledge of electricity is also required of every Construction Mechanic. In addition, the Construction Mechanic has to know enough about the operation of the equipment that he works on to be able to test his work.

Engineering Aid (EA)

The Engineering Aid carries out various duties required in surveying, engineering drawing, material estimating, and material testing. The Engineering Aid must be able to prepare construction drawings, plans, sketches, tracings, and maps. He also prepares material estimates and bills of materials required for construction projects. The Engineering Aid compiles data required for engineering studies and design. He compiles records of time spent on each project, determines work-in-place, and prepares as-built drawings for use in progress control, progress reports and/or completion reports.

In the area of surveying, the Engineering Aid makes reconnaissance, preliminary, final location, construction, topographic, and hydrographic surveys.

Equipment Operator (EO)

Jeeps, trucks, bulldozers, shovels, cranes, scrapers—you name it and you can expect to find an Equipment Operator driving it. Equipment Operators must be able to read grade stakes and to follow them to make cuts and fills. If there is earth to be moved, they move it. If there is a store of supplies to be moved, they move it. Of course, there is a lot more to it than just that. Equipment Operators must know how to take care of the piece of equipment that they are assigned to operate. They have to know how to field-check and service automotive and heavy equipment, how to rig cable assemblies, and how to change attachments on heavy construction equipment.

Steelworker (SW)

The Steelworkers handle a wide variety of jobs requiring knowledge and skill in several different areas. As the name of the rating indicates, the Steelworker works with steel. He also works with other metals and alloys. In addition, he works with various nonmetallic materials—manila line and gases, for instance.

Steelworkers must be able to erect and dismantle such structures as steel towers and tanks. They also assemble pontoons to form different types of structures. Steelworkers in the SEABEES do a lot of other things, too. They rig and erect A-frames, gin poles, derricks, booms, and special tackle to move or hoist heavy equipment, structural shapes, and materials. They splice lines and steel cables, and they make nets and slings. Another very important job they perform is placing reinforcing bars (rebars) in concrete. To perform these and other jobs, a Steelworker needs to know how to use tools and a welding torch. He must know how to read blueprints and how to cut, bolt, and weld steel shapes, plates, and built-up sections in the construction of overseas facilities.

Utilitiesman (UT)

Utilitiesmen perform numerous types of jobs. They install, operate, maintain and repair pumps, stationary steam boilers, and water distillation and purification equipment. They operate and maintain water-supply and sewage-disposal equipment. Another function is that of making prescribed chemical tests to determine the safeness and potability of water. Other main duties performed by Utilitiesmen involve plumbing and pipefitting, and installing and making operating adjustments and repairs to refrigeration and air-conditioning equipment.

E-9 Compression

In some ways, E-9 COMPRESSION is analogous to the relationship between general and service ratings. We said that general ratings identify broad occupational fields of related duties and functions, and service ratings identify subdivisions or specialties within a general rating. Using analogy, we can say that E-9 COMPRESSION is to GENERAL RATINGS as COMPRESSED RATINGS is to SERVICE RATINGS.

E-9 compression concerns those ratings that are closely related in scope and functions. (See figs. 1-26 through 1-28.) Before an E-8 can qualify for E-9, the quals (explained later) require that he be knowledgeable in both the knowledge factors and the knowledge aspects of the practical factors required of the other ratings included in his path of advancement to E-9. The bulk of his duties, however, bears heavily on administration and management. In the SEABEES, E-9s are frequently being utilized as inspectors or supervisors of overseas construction and shops.

E-9 compression has been with the Navy for some time. In some rating groups, compression did not quite measure up to the expectations of the Navy rating planners when it was created, especially among the fleet ratings—that is why some of the fleet ratings are being decompressed. This shortcoming is perhaps due to shipboard working conditions and the complexity of shipboard equipment. Once a rating is decompressed, each man is allowed to advance to E-9 in that particular rating. Incidentally, E-9 compression seems to be working well in the SEABEES.

The Group VIII ratings are compressed into three specialty groups. They are (1) Master Chief Constructionman (CUCM), (2) Master Chief Equipmentman (EQCM), and (3) Master Chief Utilitiesman (UTCM). The illustrations shown in figures 1-26 through 1-28 are self-explanatory. Study them carefully for a better picture of E-9 compression in the SEABEES.

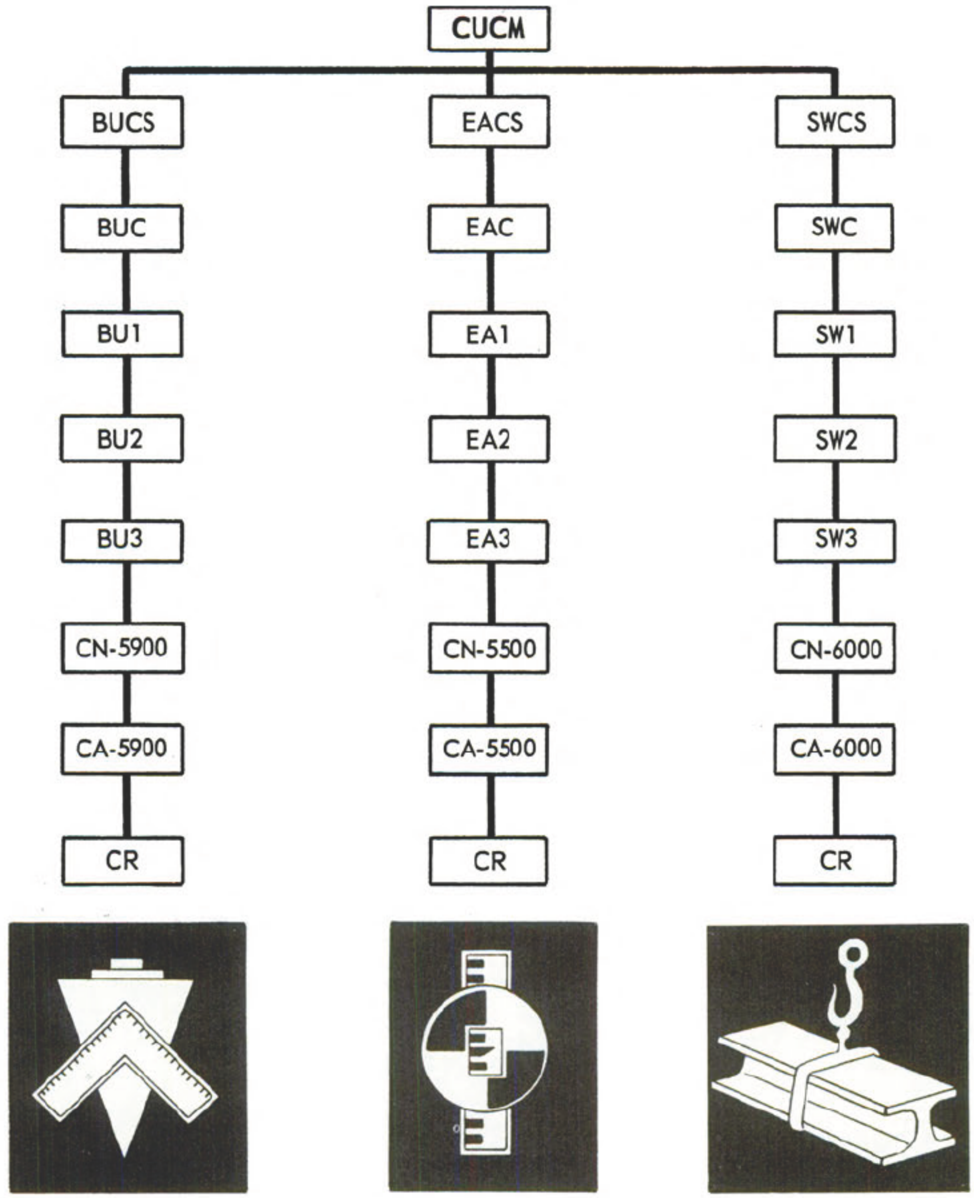
DIRECT PROCUREMENT PETTY OFFICERS (DPPOs)

In time of emergency or when our construction commitment in support of fleet operations overseas becomes great, there is immediate need of increasing the strength of the SEABEES on short notice. If the situation warrants, the SEABEES may have to activate the SEABEE Reserves. However, in a situation which is short of a declared war or emergency, such as the case in Vietnam, the SEABEES rely on voluntary enlistments. The majority of the volunteers do not have prior experience in construction. They have to be trained both technically and militarily, and are generally enlisted as apprentices. The majority of them are sent to Class A schools to learn a trade, and the rest are assigned to various units to gain experience through on-the-job training.

With a sudden increase in personnel, a shortage in the petty officer billets is created. This is where the Direct Procurement Petty Officers come into the picture. Men with construction experience in civilian occupations are encouraged to join the SEABEES and are enlisted as petty officers. The rate given to an individual is commensurate with his experience, maturity, and so on. In accordance with the vacancy in the petty officer billet, a DPPO may be enlisted in rate ranging from Third Class Petty Officer to Chief Petty Officer. Most of these men, however, come in at E-4 or E-5 level. After their enlistment, they are generally sent to CTU, Gulfport, Mississippi for 6-weeks of military training and orientation. Military leadership is given more emphasis in their training. After completion, they are assigned to various SEABEE units.

PREPARATION FOR ADVANCEMENT

Before you can advance in rate, you must fulfill certain military and professional requirements. You must study these requirements in order to pass the written examination. Your guide for study is the Quals Manual which is discussed in the next section.

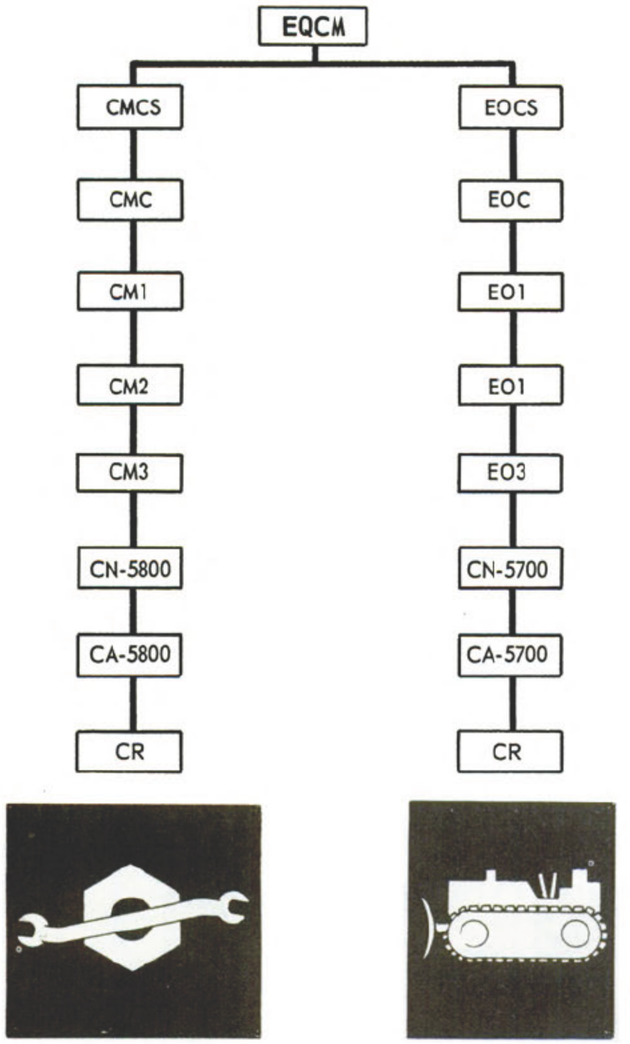


3.10(29E)A

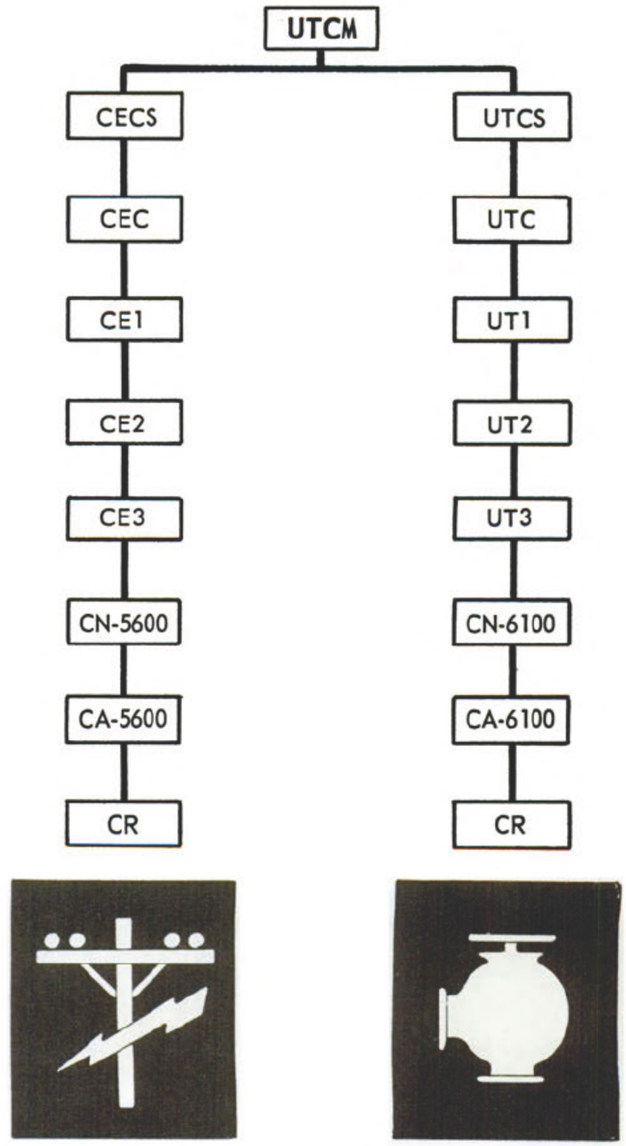
Figure 1-26.—Career pattern for BUs, EAs, and SWs.

QUALS MANUAL

One of the important publications relating to any enlisted man's career is the Manual of Qualifications for Advancement, NavPers 18068-C (with changes), known throughout the Navy as the Quals Manual. Military and professional requirements for advancing to Constructionman (and all other rates and ratings) are contained in the Quals Manual. The qualifications for Constructionman form the basis for this manual, and they were current at the date of this printing. But the qualifications change occasionally, and the questions in the advancement examinations for all pay grades are based on the latest revision. Consequently, well before taking an examination for advancement to Constructionman,



3.10(29E)B
Figure 1-27. — Career pattern for CMs and EOs.



3.10(29E)C
Figure 1-28. — Career pattern for CEs and UTs.

you should check for revisions and assure yourself that your knowledge covers all the latest qualifications.

MILITARY REQUIREMENTS

Military requirements for advancement are those general qualifications applicable to all enlisted personnel, such as watch standing, first aid, and military conduct. These requirements are published in the Quals Manual, near the front, preceding the professional qualifications. Before you can advance, you must show that you are proficient in each of the military qualifications specified for the next higher pay grade. You also may be required to demonstrate your proficiency in the military quals for all the lower pay grades. These are discussed in Basic Military Requirements, NavPers 10054-B.

You must also learn the SEABEE combat organization and the proper use of various SEABEE combat weapons. You will learn these through formal military training and study of

the SEABEE Combat Handbook, which is "must" reading for all SEABEE personnel. Study this book carefully. The knowledge you gain will not only help you to answer military questions on advancement examinations, but will also be useful in protecting yourself and your shipmates in the face of the enemy.

PROFESSIONAL REQUIREMENTS

Professional qualifications are the ones a Navy enlisted man must have to qualify for a rate (apprenticeship, third, second, first, or chief) within a particular rating. The higher the rate, the more the man is required to know.

The qualifications are further divided into practical factors and knowledge factors. Practical factors are qualifications that can be demonstrated best by performance.

A special checkoff sheet, titled Record of Practical Factors, NavPers 1414/1, lists all the practical factors shown in the Quals Manual for the rate to which you are advancing. It is kept by your supervisor or division officer; you are given a duplicate copy. As you qualify in a practical factor, your supervisor or division officer enters the date and initials the entry. When you are transferred, the checkoff sheet accompanies your record to the next duty station.

Before you can take the servicewide examination, there must be an entry in your service record to prove that you are qualified in the practical factors. The servicewide examination is based on (1) a thorough knowledge of the manner in which the practical factors are performed, and (2) the qualifications listed under the knowledge factors. For example, one CN practical factor is: Observe standard Navy safety precautions when working on or near operating engines and moving machinery. A knowledge factor is one which specifies some subject matter area of which you must have a knowledge, such as types and uses of files and rasps.

NAVPERS 10052

The Navy has set definite limits on the material for which you are accountable on a servicewide examination. The sources from which examination items are taken are listed in the effective edition of a pamphlet called Bibliography for Advancement Study, NavPers 10052 (revised). This pamphlet is available in your Educational Services Office. It is revised annually, so be sure to consult the current edition. This pamphlet provides the titles of publications and sections of publications that you should study when preparing for the examination. The publications listed contain material covering all the qualifications as shown in the Quals Manual.

Get to know NavPers 10052. After you read the instructions, only two pages are of further interest to you. One page contains the sources you should study to meet the military requirements for advancement. The other lists sources for study to qualify in a specified rating. An asterisk (*) marks the Rate Training Manuals you must complete before you can be eligible for servicewide examination for advancement.

NAVPERS 10061

You must also be familiar with NavPers 10061 (revised). This is a list of training manuals and correspondence courses of the Navy — covering courses for both officers and enlisted men. It is distributed to all Navy units and stations to inform them of the latest training manuals and correspondence courses. This publication is also kept at your Educational Services Office.

It is important to note that lots of valuable information that will be useful in the study for your rate/rating may be derived by taking additional correspondence courses other than those suggested for your particular rate/rating in NavPers 10052. Examine NavPers 10061 (latest edition) and check those courses which you think are related to the rate/rating that you are studying for. Then seek the advice of the Educational Services Officer or your senior petty officer as to which courses to take.

HOW TO ADVANCE

The Navy has established certain requirements that must be met before you are eligible to take the servicewide competitive examination for advancement. You must —

First: Meet basic requirements, such as length of service in pay grade and total service.

Second: Have a statement in your service record that you have performed satisfactorily the practical factors for the next higher rate.

Third: Have a statement in your service record that you have completed successfully the training manual for the next higher rate.

Fourth: Be recommended by your commanding officer.

When you satisfy all of these enumerated requirements, you are eligible to participate

in the examination. If you pass the examination with a high enough score, you may be advanced upon authorization of your commanding officer.

HOW TO STUDY

Good study practices are the thought practices that obtain the best results for you. Some suggestions for getting the most out of a book are included here. But, in the end, your own study habits are what you make them.

As in almost any task you undertake, a little planning increases your effectiveness. Begin by setting aside a part of each day for study. It doesn't have to be a long period of time; you will be surprised at the results produced by only 20 minutes a day of concentrated study. Once you begin, work at it steadily. It is better to study more often for shorter periods than it is to study occasionally for long periods. You shouldn't try to absorb too much information at a time.

When you start to study, go quickly through the material you intend to study. Check the headings and perhaps read the first paragraph of each section to find out what the material is about. Pause for a moment to think about it, and phrase in your mind: "I am going to study about so-and-so. Included in this are such subjects as blank-and-blank." Then quickly read through the entire unit. Next, study each section carefully. Pause frequently to summarize what you have read, restating the information in your own words. Try to tie it in with what you already know about equipment or procedures used in your battalion or station. Make a point of discussing what you have learned with other Constructionmen and your division petty officers.

Don't be afraid to ask questions of the leading petty officers in your division. One of their primary duties is to instruct the men under them, and they will be pleased that you show enough interest to seek their advice.

REWARDS OF ADVANCEMENT

Each time you advance to the next higher level, you receive many rewards. These rewards include higher pay and allowances, together with additional pension benefits when you retire. But the really important gains are opportunities for more interesting and challenging assignments, increased respect from your superiors as well as from the men you supervise or help, and the chance for greater fulfillment of your abilities. Above all, you are afforded the opportunity to serve your command, your Navy, and your country at a higher level of responsibility in a more important job.

As a member of the greatest Navy in the world, you have the satisfaction of knowing that, as you advance, you are serving your country in a most important way. Do your job well at all times, and take pride in what you do and how you do it. Service to your country is a special privilege. You must make every endeavor to serve with honor.

Tradition, valor, and victory are the Navy's heritage. The long history of outstanding achievements and noble service of the Navy provides an inspiration and a challenge to you and your shipmates. It is up to you to help maintain and enlarge the prestige and the traditions of the naval service.

CONSTRUCTIONMAN OPPORTUNITIES

Interest alone is inadequate as a reason for selecting a particular rating to strike for. You also should possess an aptitude or basic ability to perform the work requirements of the rating. Obviously, you wouldn't strike for the EA rating if you don't have a ready mind for figures, and the patience to do minute details, such as those you may encounter in preparing engineering drawings. Nor would you strike for CM if you hate the smell of grease, and you are aware that you do not possess the manual dexterity that is characteristic of all skilled mechanics.

It is important that you make the proper choice at this stage of your career. Talk to rated men who are in the specialty in which you have an interest, and ask them to explain their work to you. Perhaps, if you are not already working with them, you should visit their places of work to see how they perform their daily assignments.

Being a young SEABEE, your opportunities are not only limited to advancement in one of the enlisted ratings, but you have a wide range of choice which is dependent upon your ability, initiative, determination to learn, and your ideals. You might be good officer material! It might interest you to know that a great number of our naval officers were former enlisted men. There are even a few admirals who came from the ranks. When they were young, like you are, they applied for one of the various officer programs. Some went through the Naval Academy

at Annapolis, Maryland, the Naval Cadet Aviation (NAVCAD) program at Pensacola, Florida, the Navy Enlisted Scientific Education Program (NESEP) in one of the participating colleges and universities, and other programs. It is beyond the scope of this training manual to discuss these various programs. Each program has different requirements which are subject to change, so the best way to get up-to-date information is to visit your Educational Services Officer. The Educational Services Officer should have all the information and he can tell you if you are qualified or not to apply for one of these programs. The visit does not cost you anything, so go now and find out anyway, even though you have doubts about your qualifications.

If you are making the Navy your career, you may as well shoot for the highest spot you can reach. It is not easy, but the rewards in terms of prestige, responsibility, and pay need not be overemphasized. Act now!

YOUR PLACE IN THE SEABEES

By now, you are familiar with the SEABEES' history, organization, accomplishments, and so forth. Your path of advancement and some suggestions that will help you to advance have been given, a main objective being to familiarize you with your new organization so that you will realize your importance as a member. You are a member of a team; and, like on any other team, your job, however minute, is a contributing factor in the accomplishment of your Navy's mission. The mission of your present unit may appear different from that of other SEABEE units; however, you should realize that your duty station is a part of a larger SEABEE organization which is, in turn, meshed-in with the whole naval organizational structure. (Refer back to figs. 1-5 and 1-6.) You might be serving in a SEABEE unit which is a part of the Naval Operating Forces (the Fleet), or a part of the Naval Shore Establishment. If you happened to be assigned in a Naval Mobile Construction Battalion or in an Amphibious Construction Battalion, you belong to the Naval Operating Forces; if you are in one of the SEABEE schools (NAVSCON), or on duty with a Public Works Center (PWC), then you are with the Naval Shore Establishment. The primary mission of the Naval Shore Establishment is to support the naval operating forces. The shore establishments provide the personnel, training, and logistical support for the fleet.

The SEABEES' major shore establishments are the Construction Battalion Centers which are presently located at three major bases. As you perhaps already know, they are located at Davisville, Rhode Island, at Port Hueneme, California, and at Gulfport, Mississippi. If you will look at a map of the United States, you will see that all of these locations are readily accessible by land and sea transportation. They are so located to facilitate the movement of heavy construction equipment, construction materials, and other logistical support requirements for the SEABEES when deployed overseas.

Whatever your assignment is, you are either training for a specialized SEABEE trade or performing regular duties in support of your unit's mission. You will be under the supervision of a petty officer who will teach you the required skills and/or direct you to perform certain tasks necessary for the accomplishment of your unit's mission. His interest in you does not only cover official tasks relative to the Navy's function; he will assist you with your personal problems and he will be responsible for your safety and welfare during the accomplishment of a mission. He may not have all the answers to your questions, but he will attempt to find answers he cannot give you readily, or he will direct you to see the person who is in a position to know.

For the present, the diversity of your duties may seem undefined and without limit. In addition to your military duties, you will be directed to perform other duties which you may think do not have any relation to the rating for which you are striking. Always think of such assignments as a challenge rather than odd work. Be positive in your thinking; if you have this kind of attitude, you will realize that whatever function you are doing boils down to some kind of training and its proper accomplishment will be a part of your experience.

The human being is the most important asset of any organization; the young SEABEES of today are the hopes of our SEABEES of tomorrow. The SEABEES' fame and tradition will be as good as its members mean it to be. The SEABEES are well-known for their creativity, cooperation, and hard work. Carry on with this tradition. In order to get involved, you must feel that you are a part of it. Have pride in the SEABEE organization and always strive to do whatever task is given you to the best of your ability. As in civilian society, certain rules and regulations must be followed in order to maintain proper decorum and control; this is even more

so in the service. In the Navy, the majority of our actions are governed by the standards set forth in Navy Regulations (Navy Regs.), and by Navy traditions and customs. You must be aware that the line of communication from top to bottom and vice versa is always open, provided that the proper channels are adhered to. That is, if you want to talk formally to your Commanding Officer (request mast), your chit must pass through your leading petty officer, the leading chief, the division officer, the department head, and the Executive Officer, before it finally reaches the Commanding Officer. Your chit may be disapproved along the way, but that does not mean that it will stop there; your chit must still reach the "old-man"—unless the person who disapproved it talks to you and you decide otherwise.

CHAPTER 2

TRANSPORTATION

The Navy has an enormous investment in transportation equipment. In addition to the original purchase costs, there is the expense of operation, repair, and upkeep of this equipment. The Navy's mission makes it essential for skilled personnel to be available to operate, maintain, and repair this equipment. No matter how great the value of a piece of equipment, it is useless without personnel who know how to utilize it.

In the SEABEES, it is the Construction Mechanics who are mainly responsible for the repairs, adjustments, and preventive maintenance necessary to keep transportation equipment in safe and efficient operating condition. It is important to note, however, that an operator is responsible for performing certain service checks and inspections on equipment assigned to him. Often, the operator also handles minor adjustments and various basic maintenance duties, such as lubrication, required for a particular piece of equipment. Operators are the first line of defense against equipment wear, failure, and damage. You can see, therefore, why it is expected that an operator will do more than merely operate the equipment assigned to him.

The duties of an Equipment Operator and of a Construction Mechanic are broad in scope. If you believe that you would like to strike for either of these ratings, now is the time to start learning the basic essentials of operating, maintaining, servicing, and repairing transportation equipment. This chapter and chapter 3 are intended to acquaint you with some of the major duties which you, as a Constructionman, will perform when you are working with Equipment Operators. It is also intended to acquaint you with the major types of transportation equipment with which Equipment Operators work. Chapter 4 discusses the types of duties which the CN performs when working with Construction Mechanics.

In this chapter, we will discuss some of the common types of transportation equipment with which the SEABEES are likely to be concerned. We shall also discuss certain subjects related to road safety, such as road signs, hand signals, and overtaking and passing. Most of the information in this discussion applies to both private automobiles and Navy vehicles.

TRANSPORTATION EQUIPMENT

The Naval Facilities Engineering Command (NAVFAC) has technical responsibility in matters related to Navy transportation equipment. NAVFAC defines transportation equipment to include all types of automotive vehicles, construction equipment, weight-handling equipment, and railroad equipment. Technical responsibility includes responsibility for the operating procedures and standards pertaining to the alteration, repair, and upkeep of transportation equipment. Many of the procedures required by NAVFAC with respect to this equipment are given in <u>Management of Transportation Equipment, NavDocks P-300</u>. From time-to-time, NAVFAC issues directives on transportation matters.

AUTOMOTIVE VEHICLES

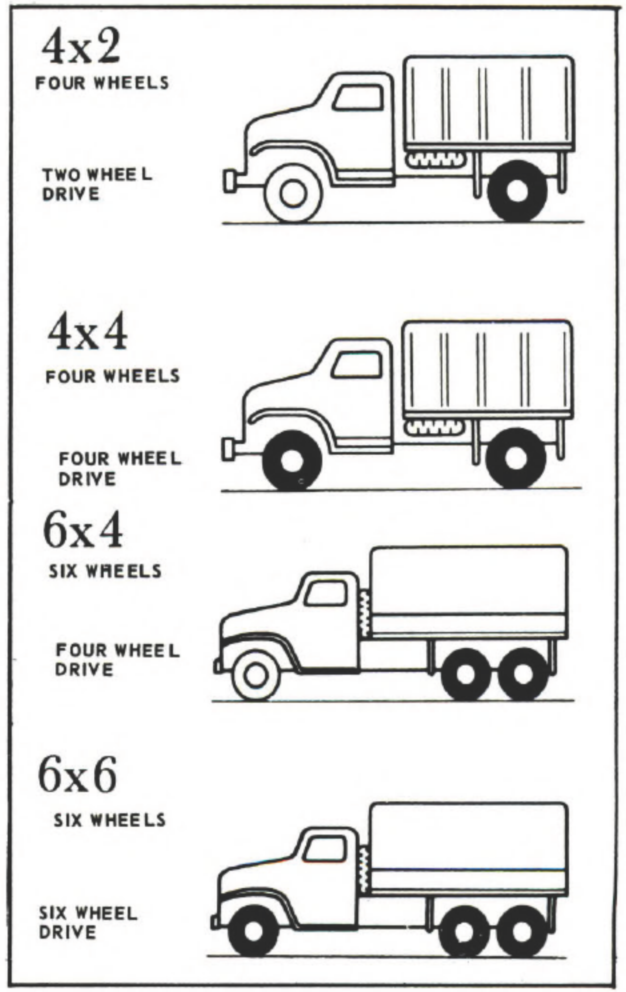
The term AUTOMOTIVE VEHICLES includes all noncombatant, self-propelled motor vehicles suitable for use on the highway, and all trailers suitable for use in conjunction with these vehicles. It includes ambulances, structural fire trucks, trucks, buses, tractors, bus trailers, semitrailers, all types of passenger vehicles, and all types of power cycles. It does not include bicycles, vehicles designed primarily for use on rails, construction equipment, materials-handling equipment, amphibious vehicles, or vehicles (with or without armor) designed for active participation in combat.

The Navy uses both commercial and military types of automotive vehicles. A commercial type is one which is similar in construction to a

vehicle used in civilian life; such as the ordinary Navy sedans and buses. A military-type vehicle is one which is specially designed for military use, more ruggedly constructed, and not manufactured for use by the general public.

Vehicle Drive-Wheel Terminology

A standard terminology has been established to express the number of wheels on a vehicle and the number of those wheels that are drive wheels. A 4x2 vehicle, for example, has four wheels, two of which are drive wheels. A 4x4 vehicle has four wheels, all four of which are drive wheels. A 6x4 vehicle has six wheels, four of which are drive wheels. In each case, the first figure indicates the total number of wheels and the second figure indicates the number of those wheels that are drive wheels. Figure 2-1 illustrates vehicle drive-wheel terminology.



29.31
Figure 2-1. — Vehicle drive-wheel terminology.

Passenger Motor Vehicles

The most common types of passenger motor vehicles are automobiles, buses of the commercial type, carryalls, and station wagons. AUTOMOBILES are usually four-door sedans with all-steel bodies and powered by 6- or 8-cylinder engines. A typical Navy sedan is shown in figure 2-2. Common makes used by the Navy include Chevrolet, Ford, Rambler, Plymouth, and Dodge.

Typical Navy BUSES are 1 1/2-ton, 4x2, 17-passenger vehicles or 2 1/2-ton, 4x2, 37-passenger vehicles. Common makes are International, Ford, Dodge, and GMC. Figure 2-3 shows one of the latest models used by the Navy. It is a 37-passenger bus which you perhaps used in boot camp.

CARRYALLS are so called because they carry both personnel and light cargo. The typical Navy carryall is a commercial type, 1/2-ton, 4x2, 8-passenger vehicle. The middle and rear passenger seats are removable. The body has windows all the way around, and is equipped with a hinged tailgate and a lift-type rear door. Carryalls are commonly used to transport surveying crews to jobsites. One type of carryall used by the Navy is shown in figure 2-4.

A carryall is sometimes classed as a truck, but for assignment purposes, it is considered a passenger vehicle.

STATION WAGONS are similar to carryalls. The main difference is that a station wagon is

115.197
Figure 2-2. — Sedan.

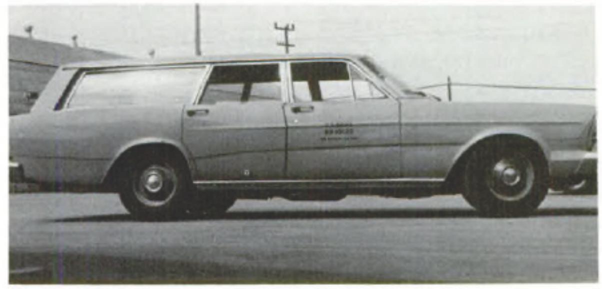
115.198
Figure 2-3. — A 37-passenger Navy bus.

115.1
Figure 2-4. — Carryall.

built on an automobile chassis, whereas a carryall is built on a half-ton truck chassis. Station wagons are gradually replacing carryalls as passenger-carrying vehicles. A station wagon is shown in figure 2-5.

Ambulances

Ambulances are classed as special-type vehicles. One type (military) generally used by the SEABEES when on deployment is shown in figure 2-6. Generally, those used by Navy hospitals in the Continental United States are of the commercial type. Commercial-type ambulances are usually 1/2-ton, 4x2 vehicles equipped with two stretchers, two field litters, and one side bench. This type of ambulance is usually powered by a V-8 engine. Military-type ambulances are usually 3/4-ton, 4x4 vehicles equipped to accommodate four litters and having two side



29.32
Figure 2-5. — Station wagon.

115.199
Figure 2-6. — Ambulance (military type).

seats. An ambulance of the military type is usually powered by a 6-cylinder engine.

TRUCKS

The Navy uses most of the well-known American makes of trucks, such as International, Dodge, Ford, Chevrolet, GMC, Mack, and Diamond-T.

Besides the commercial and military classification and the wheel classification (4x2, etc.), Navy standard trucks are classified by weight-carrying capacity and by body type. LIGHT trucks can carry from 1/4 to 1 1/2 tons; MEDIUM trucks from 1 1/2 to 2 1/2 tons; and HEAVY DUTY trucks more than 2 1/2 tons.

A body-type classification may refer to the principal purpose for which the truck is used (such as CARGO), or to the physical character of the particular body (such as STAKE, VAN,

or DUMP). The most common Navy standard trucks, classified by body type, are panel, utility, and cargo. A brief description of each of these types follows. As mentioned before, carryalls may be classified either as passenger-carrying vehicles or as trucks; they are described under passenger motor vehicles.

Panel Trucks

As we have seen in figure 2-4, a station wagon has windows all the way around. A PANEL truck (fig. 2-7) is steel-enclosed, except for the windshield, door, windows on either side of the cab, and rear windows. (Some panel trucks do not have rear windows.)

The typical Navy panel truck is a commercial-type, 1/2-ton or 1-ton, 4x2 vehicle with an all-steel body equipped with double rear doors.

29.34
Figure 2-8. — Utility truck, 1/4 ton (jeep).

Utility Trucks

The UTILITY truck is better known by the term JEEP. The Navy commercial-type utility truck is a 1/4-ton, 4x4 vehicle equipped with a removable rear seat, folding canvas top, and folding windshield. The military-type utility truck (fig. 2-8) is very similar, but is more strongly built. Canvas side curtains are available for both types.

29.35
Figure 2-9. — Pickup truck.

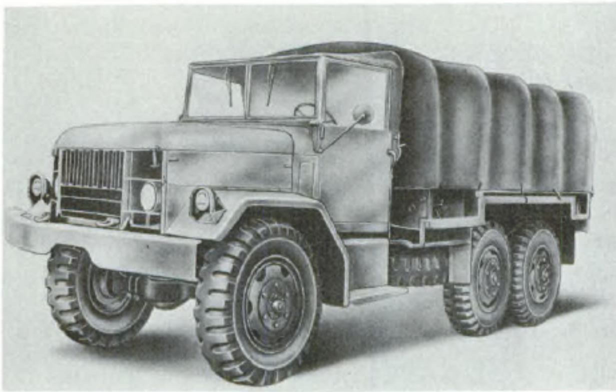
Cargo Trucks

The smallest of the Navy cargo trucks is the PICKUP truck shown in figure 2-9. A Navy pickup may be 1/2-, 3/4-, or 1-ton capacity. It has a variety of body styles and can haul up to five passengers. Drives may be 4x2 or 4x4. Some pickups are equipped with TOP BOWS (wooden arches) for supporting a canvas roof and folding rack seats for carrying personnel.

29.33
Figure 2-7. — Panel truck.

A Navy 5-ton, 6x6, military-type cargo truck is shown in figure 2-10. The truck has an open-type body, which may be covered with top bows and a canvas roof. The open body contains seats for transporting troops. The Navy also uses a 2 1/2-ton, 6x6 of the same type.

A STAKE truck, commercial type, is shown in figure 2-11. This type of truck has a flat, wooden platform bed with removable sides and rear stakes. The Navy uses a wide range of stake trucks; the most common are 2-ton 4x2's and 4x4's, 2 1/2-ton 4x2's, 5-ton 6x4's, and 10-ton 6x4's.



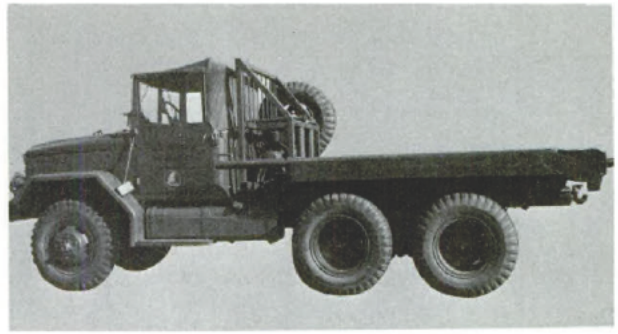
29.36
Figure 2-10. — Cargo truck, 6x6, military type.

29.37
Figure 2-11. — Stake truck.

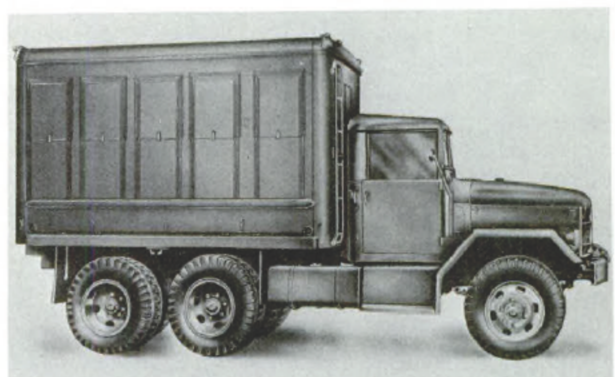
A military-type, 2 1/2-ton, 6x6, FLATBED (or OILFIELD bed) truck is shown in figure 2-12. The body has recesses for nesting gin poles when not in use, and a steel rack at the front for support of an A-frame. Flatbeds are used extensively for carrying stacked pipe in pipeline and oilfield construction.

A military-type, 2 1/2-ton, 6x6, VAN truck is shown in figure 2-13. Vans are used for a variety of purposes; the one shown in figure 2-13 is designed for the installation of various groups of equipment required for a complete specialized mobile shop.

A commercial-type DUMP truck is shown in figure 2-14. The Navy frequently uses gasoline-engine powered, 2 1/2-ton, 4x2's; 5-ton 6x4's;



29.38
Figure 2-12. — Military-type flatbed or oilfield bed truck.



29.39
Figure 2-13. — Van truck, military type.

29.40
Figure 2-14. — Dump truck, commercial type.

and 10-ton 6x4's. It also uses a diesel-engine powered, 15-ton, 6x4.

A military-type, 2 1/2-ton, 6x6, cargo dump truck is shown in figure 2-15. The Navy may also use a 5-ton, 6x6, military type.

Special-Purpose Trucks

Besides the standard trucks, the Navy uses a good many SPECIAL-PURPOSE trucks. Trucks of this type are usually classified by reference to their special purpose. A few typical Navy special-purpose trucks are:

Transit-mix
Fuel tanker
Line construction and maintenance
Wrecker

A brief description of each of these special-purpose types follows.

A TRANSIT-MIX truck is a truck-mounted concrete mixer. The truck may be used either as an AGITATOR or as a MIXER. When used as an agitator, the truck takes on a load of mixed concrete at a concrete plant, and agitates the mix (by slowly rotating the drum on the mixer) while enroute to the place where the concrete is to be used. The purpose of agitation is to prevent the concrete AGGREGATE (sand, gravel, and stone) from SEGREGATING (grouping together by sizes) during the trip.

When used as a mixer, the truck takes on a load of batched dry concrete ingredients (cement and aggregate) at the batching plant, adds the correct amount of water from its own water tank, and mixes the concrete as it proceeds to the place where the concrete is to be used. The interval between the addition of water and the final placement of concrete must be not more than an hour.

Figure 2-16 shows a transit-mix truck. These machines are classified according to the number of cubic yards of concrete they can mix or agitate. One type of machine used by the Navy has a capacity of 3 cu yd as a mixer, 4 1/4 cu yd as an agitator. Another has a capacity of 4 1/2 to 5 cu yd as a mixer, 6 1/8 cu yd as an agitator.

A FUEL TANK truck, 2 1/2-ton, 6x6 military type, is shown in figure 2-17. This truck has a capacity of 1,200 gallons of fuel, carried in a three compartment steel tank. Compartment separation is a safety feature which minimizes the dangers of fire. Equipment includes a 100-gallons per minute loading and discharging pump, storage compartment for hose and dispensing nozzle, and metering device to measure dispensed fuel. The Navy also uses other types of fuel tanks with greater capacity.

A 6x6, military-type, LINE CONSTRUCTION and MAINTENANCE truck is shown in figure 2-18. This truck carries the tools and equipment required for the construction and maintenance of electric powerlines. The truck has an all-steel body which contains individual storage compartments fitted with shelves and partitions. All compartments are accessible from outside through hinged doors. The truck is equipped with a power winch, a pole derrick, and ladder racks. The Navy also uses a 4x4, commercial type of line construction and maintenance truck.

29.41
Figure 2-15. — Cargo dump truck, military type.

29.42
Figure 2-16. — Transit-mix truck.

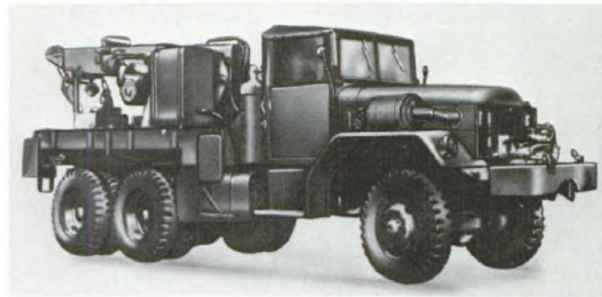
29.43
Figure 2-17. — Fuel tank truck.

29.44
Figure 2-18.—Line construction and maintenance truck.

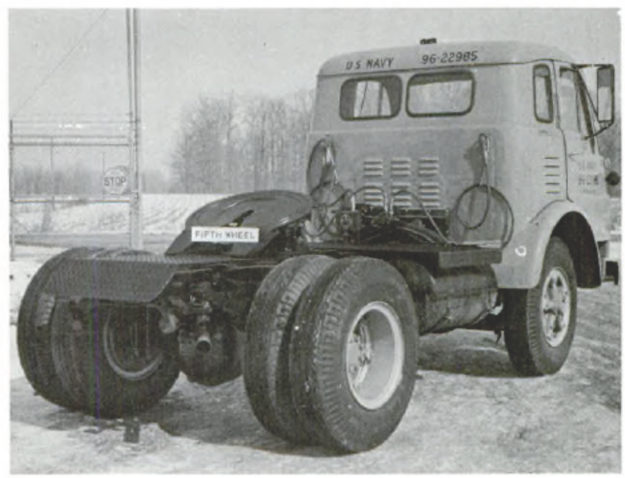
A 5-ton, 6x6, military type WRECKER truck is shown in figure 2-19. It is equipped with a hydraulically operated crane and front- and rear-mounted winches. It is designed to retrieve disabled lightweight and mediumweight vehicles and may accomplish light crane work in the field. It has a maximum lifting capacity of 10,000 lbs (5 tons).

Truck Tractors

A TRUCK TRACTOR (fig. 2-20) is used to tow a SEMITRAILER. A semitrailer has road wheels at the rear only. The forward end of a semitrailer is equipped with a FIFTH WHEEL UPPER PLATE containing a KINGPIN, which engages a KINGPIN LOCK on the FIFTH WHEEL of the truck tractor.



29.45
Figure 2-19. — Wrecker, military type.

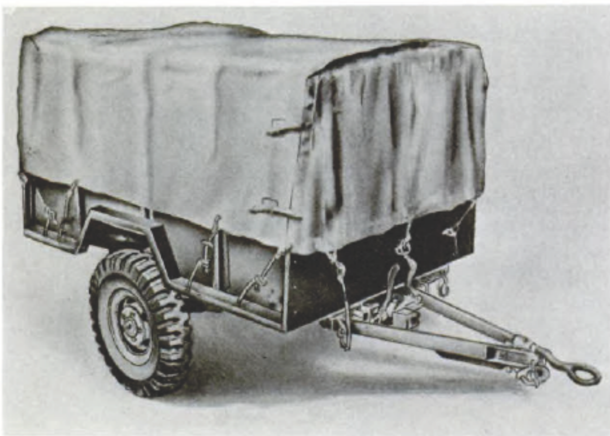


29.46
Figure 2-20. — Truck tractor.

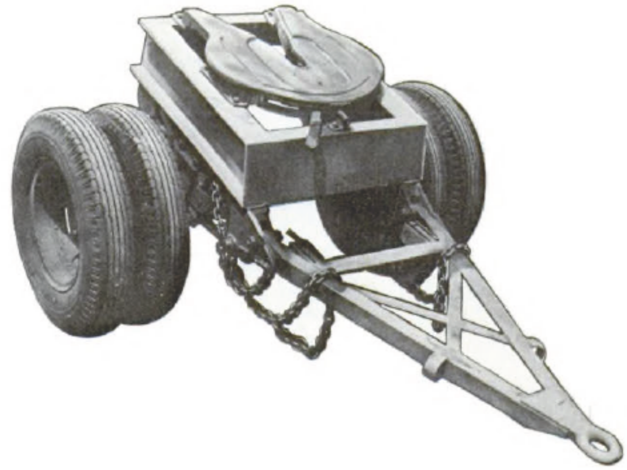
Gasoline-engine powered truck tractors used by the Navy are 5-ton 4x2's, 7 1/2-ton 4x4's, 10-ton 4x4's, and 15-ton 6x4's. The Navy also uses diesel-engine powered 10-ton 4x2's, and 10-ton 6x4's.

TRAILERS AND SEMITRAILERS

A vehicle which is not self-propelled and which is designed to be towed by a self-propelled vehicle is either a TRAILER or a SEMITRAILER. A trailer can be towed by any ordinary type of vehicle. It is equipped with a tongue which can be coupled to a PINTLE or TRAILER HITCH on the rear of the towing vehicle. A military-type cargo trailer is shown in figure 2-21.



29.47
Figure 2-21. Military-type cargo trailer.



29.48
Figure 2-22.—Trailer converter dolly.

A semitrailer can be towed only by a truck tractor. When not coupled to a truck tractor, the forward end of a semitrailer is supported by LANDING JACKS. These devices can be manipulated to raise and lower the forward end of the semitrailer for uncoupling from or coupling to the truck tractor.

Semitrailers are made in a variety of body types, including STAKE, CARGO VAN, GASOLINE TANK, PERSONNEL, and LOW BED (usually called LOWBOY).

A TRAILER CONVERTER DOLLY (fig. 2-22) is used to convert a semitrailer into a trailer. This makes it possible to tow the semitrailer without using a truck tractor.

WEIGHT-HANDLING EQUIPMENT

In a broad sense, the term WEIGHT-HANDLING EQUIPMENT includes all equipment used for lifting, transporting, and loading material. As used in NAVFAC publications, however, weight-handling equipment does not include materials-handling equipment (described in the next section). Cranes, derricks, and hoists are the main types of weight-handling equipment to which NAVFAC publications refer. Truck and crawler cranes are considered weight-handling equipment when used principally for weight-lifting purposes.

The power crane and its various attachments will be described and illustrated in chapter 3.

MATERIALS-HANDLING EQUIPMENT

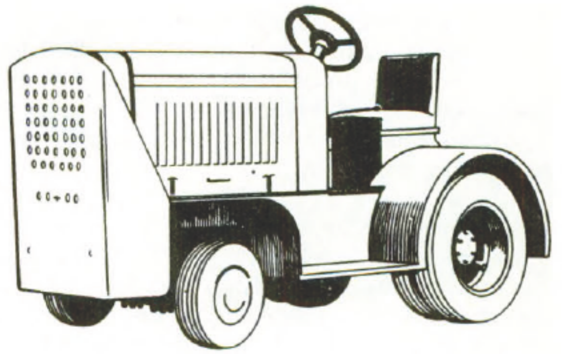
All mechanical equipment normally used for handling materials on floors and paved surfaces in and around depots, docks, terminals, industrial plants, and similar locations where materials must be handled or stored is classified as MATERIALS-HANDLING EQUIPMENT. Fork lifts, pallet trucks, warehouse tractors and trailers, stackers, and straddle trucks are examples of materials-handling equipment.

The most common types of materials-handling equipment with which you will work as a CN are the FORK LIFT and the WAREHOUSE TRACTOR (often called DOCK MULE). A fork lift is a powered vehicle used to lift and carry heavy objects. It may be powered either by an internal combustion engine or by an electric motor. The various makes and models of fork lifts range in load-lifting capacity from 2,000 pounds to 15,000 pounds. The maximum height to which a fork lift can raise a load varies, approximately 200 inches being the maximum.

A fork lift may have solid rubber tires or pneumatic (air filled) tires. Generally speaking, small fork lifts which work mainly inside buildings have solid rubber tires, and large fork lifts which work outside have pneumatic tires.

Of recent design is the rough terrain fork lift, which is capable of operating on rough terrain and in the surf. (See fig. 2-23.) Rough terrain fork lifts are highly maneuverable with their four-wheel drive and four-wheel power

5.58
Figure 2-23.—Rough terrain fork lift, Pettibone R.T. 6000.



29.30
Figure 2-24.—Dock mule.

steering. Too, they have the ability to tilt their frames left or right up to 10° to maintain the lifting forks and the load on a level. The rough terrain fork lift generally used by the SEABEES in construction sites and in supply yards is the Pettibone R.T. 6000. It is shown in figure 2-23.

DOCK MULES (fig. 2-24) are small, maneuverable tractors designed to tow small trailers used in loading and unloading operations. A dock mule may be powered by either an internal combustion engine or by an electric motor. It may have either three or four wheels.

TRANSPORTATION OPERATIONS

The nerve center of transportation operations is the MOTOR POOL. In a Public Works transportation department, for example, the motor pool is the place where the operation of automotive and construction equipment is coordinated. It is usually located in the same building as the repair shop, transportation office, and dispatch office, where necessary records are kept, and the proper management and control of automotive and construction equipment are handled. The same building generally houses the spare parts, tires, and other supplies necessary for maintenance and operation of automotive and construction equipment. Located in the motor pool parking lot is a service station to provide fuel, oil, air, and water as required. In an NMCB, it is sometimes the headquarters for ALPHA Company (Equipment Operations and Maintenance Company).

A CN assigned to transportation duties is likely to be assigned to the motor pool. Your main duties as a member of the motor pool will probably consist of operating and servicing light vehicles, such as passenger sedans, station wagons, pickup trucks, and the like. The motor pool operates under the general direction of a dispatcher, who assigns personnel in the motor pool to various duties. You may be assigned regular runs of guard mail, U. S. mail, commissary supplies, and the like; you may be assigned to operate a particular vehicle, such as the commanding officer's car or the ambulance; or you may be assigned to the ready room to await calls for transportation. It is the job of the dispatcher to determine where the services of men in the motor pool can best be used.

On rare occasions, you may be assigned to dispatching operations; in such a case, you will be given clear and explicit instructions as to the extent and scope of your authority. Duties of this nature consist mainly of seeing that vehicles are dispatched according to schedule and that proper records are kept.

In operating a vehicle, it is essential that you follow prescribed rules. A knowledge of safety regulations, road signs, and required operator's forms is also important.

OPERATOR SERVICE CHECKS

To ensure that a vehicle is ready for operation at all times, the operator should make a systematic service check or inspection before operation, during operation, and after operation. These checks are necessary if defects are

to be discovered before they result in serious damage or breakdowns. Major points that should be covered in these service checks are discussed below. In addition to the points listed, you may want to include others that you feel are equally important.

Prestarting Checks

Many a breakdown might be prevented if all vehicle operators made a careful check of certain items before starting out with a vehicle. Offhand, a prestarting check covering all items named in this discussion may seem like an all-day project. With a little experience, however, only a few minutes generally will be required because some of the items can be checked visually on approaching the vehicle or walking around it. Certainly a few minutes given to a prestarting inspection is time well-spent considering the inconvenience and delay that could result from an accident or breakdown on the road. What is more important, the safety of the operator is at stake when he drives a vehicle that is in poor running condition.

No step-by-step procedure is stressed in making a prestarting inspection. It is suggested, however, that you first complete the checks that can be made from the exterior of the vehicle, and then perform those that can be made from the driver's seat in the cab of the vehicle.

Take a quick look at all tires to ensure that none is soft. Good tires are essential to safety; more details on tires will be given later in this chapter.

Check the lenses of the front and rear lights; if dirty, clean with a soft cloth. A film of mud or dust can greatly reduce the intensity of the lights.

Check under the vehicle for leaks—a fresh wet or oil spot on the ground is an indication that a leak may be present.

Raise the hood of the vehicle and check the coolant in the radiator and the battery water. If either the coolant or the water is low, bring it up to proper level.

Check the oil level. In making this check, withdraw the oil dip stick, wipe it with a cloth or paper towel, replace it, and withdraw it a second time for the check. When necessary to add oil, make sure you use the proper type and weight.

When checking the oil supply, it is a good idea to check the condition of the oil. Note carefully the consistency and color of the oil on the dip stick. Rub a drop of the oil between your finger tips and you can tell if it is gritty or lacks body. Examine the fan belt to see if it is frayed, worn, too loose, or too tight.

After closing the hood, you would be wise to check to make sure it is latched securely. If you were going around a sharp curve and the hood should spring up so that you could not see the road ahead, the results might easily spell disaster; so don't overlook this safety check.

See that all items of emergency-type equipment, as required locally, are on hand. Emergency-type equipment might include such items as towchain or rope, wheel-changing tools, and spare wheel and tire. You can imagine what it would be like trying to change a flat tire without a lug wrench and jack. You may not often need a towchain or rope, but this equipment would come in handy if you should get stuck. You never know when you may have a flat tire or blow out, so a spare wheel should be provided for such an emergency. As a reminder here, make sure the spare wheel and tire fit the vehicle and, by all means, see that the tire is inflated.

Some Navy vehicles are equipped with fire extinguishers. The logical place for the fire extinguisher is near the driver. See whether a fire extinguisher is available and where it is located so that you could get to it easily if needed.

As part of your prestarting inspection, take a close look at the windows to see if any glass is cracked or broken. Check the operation of the windows and try the doors to see that they open and close properly. If your windshield and windows are dirty, clean them with water and paper towels or soft cloth.

If you are in a climate subject to freezing temperatures, you may sometimes have to scrape ice or snow off the windshield and windows. Besides scraping, start the engine and let it warm up, with the defroster in ON position, before starting out on the road. As you perhaps know, various types of hand scrapers are available, and most any type is suitable so long as it does not scratch the glass.

Now let us consider some "behind the wheel" checks to make after entering the cab and before getting underway with the vehicle. First

check the driver's seat to ensure it is adjusted to give you the best position for comfort and visibility while driving. The seat can be moved forward or backward by pressing on the lever at the side of the driver's seat.

Check the horn and the windshield wipers to make sure they work properly. Adjust the rear view mirror so that you will be able to check traffic behind your vehicle while driving.

Two items requiring special attention are the handbrake and the service (foot) brake. The handbrake — also referred to as the parking brake or the emergency brake — operates independently of the service brake. By the way, there are two kinds of handbrakes. The older type is actually an emergency brake. Some of the modern handbrakes are only parking or holding brakes. It is important that the ratchet, or other automatic locking device, hold the handbrake in applied position when the lever is pulled out. This locking device also must be capable of being properly released. The handbrake should be adjusted if you have to pull it out more than halfway of its travel to make it hold.

Check the service brake to be sure it works properly. Note carefully the amount of pedal travel. When brakes are fully applied, there should be at least a 2-inch clearance between the pedal and the floorboard.

Bad brakes may cost you your life! Do not drive a vehicle if the brakes are soft or spongy. If brakes are defective, see that the cause is determined and the necessary corrections or repairs made before driving the vehicle. As a safeguard to yourself and others, don't take chances with faulty brakes!

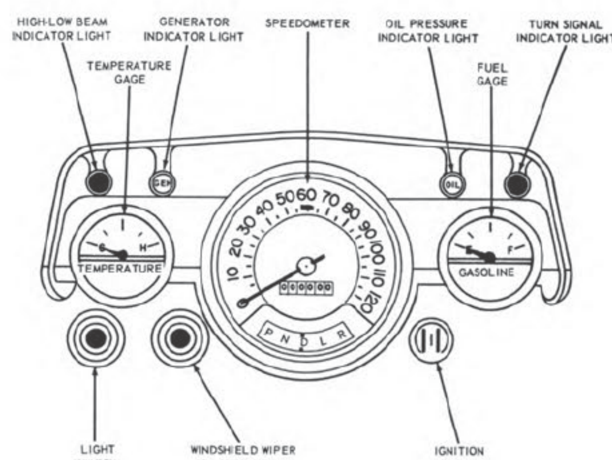
Another item deserving careful attention is the lights. If possible, have a coworker observe while you operate the light switch and controls inside the cab. First check the parking lights. Then check to see that all outside lights burn. Try the headlights on both high and low beams. Have your coworker observe the stoplights to see that they operate properly. See that the turn signals work properly.

The lights on a vehicle should be in proper working order even though the vehicle is ordinarily used only during daylight hours. As you know, weather conditions — such as a thick fog or heavy thunderstorm — sometimes require the use of lights as a safety measure during daylight hours.

If you have ever run out of gasoline miles away from your activity, you know the importance of checking the fuel supply before starting out on a trip. The gasoline gage on the instrument panel in front of the driver's seat will tell you the amount of fuel in the tank. The gage will not work, however, with the ignition turned off. So insert the key in the ignition switch and turn to the ON position; then observe the reading on the fuel gage. If the fuel supply is not adequate, have the tank refilled before starting out on a trip. This is an operator responsibility.

Checks During Operation

While driving, a good vehicle operator will give constant attention to the various gages and indicators mounted on the instrument panel. On late-model passenger cars you will likely find a generator indicator light, an oil pressure indicator light, a temperature gage, the speedometer, and a fuel gage. The arrangement of these lights and gages may vary, depending upon different makes and models of vehicles. However, they are generally near the speedometer, so that they can be viewed easily by the driver during operation of the vehicle. A typical example of common types of gages, instruments, indicator lights, and switches such as you might find on a late-model passenger car, and their arrangement, is pictured in figure 2-25.



29.49
Figure 2-25. — Gages, instruments, and controls.

The temperature gage indicates the engine coolant temperature. With a gage like that in figure 2-25, the needle ordinarily will hold around the center of the dial spread. Under certain conditions, such as extremely hot weather, the temperature gage may register higher than normal readings. In case the needle moves near the H (HOT) mark on the dial, consider this a signal that something is wrong. Stop promptly until the cause of overheating is determined and the trouble corrected.

On some vehicles, the temperature gage is a dial (shown in figure 2-25) marked to show a variation of temperature, and on others it may be a red "HOT" warning light. Under normal conditions, a gage should hold at a temperature of about 160 to 180 degrees after the engine is warmed up. If the needle of this gage shows a shift during operation to the highest temperature mark, stop your vehicle and have the trouble located and corrected.

You will note that the oil-pressure indicator and the generator indicator shown in figure 2-25 are the same in appearance. But the letters "Gen" appear on the face of the generator indicator and the word "Oil" identifies the oil indicator. Each is designed so that a red light will come on and burn continuously if trouble develops in that particular system. We might point out that with either indicator the light should light when the key is turned to "ON" and it is not unusual for the red signal to come on when your engine is idling; so don't mistake this as a trouble signal. But, if the red light in either indicator comes on and REMAINS on while the vehicle is in operation, you can be sure this is a signal of trouble. When this happens, stop the vehicle and have the source of trouble located and the necessary correction or repair made.

The fuel gage, as you know, indicates the amount of fuel in the tank of the vehicle. As a safeguard against running out of fuel, it is good practice to refill the tank when the needle reaches the one-quarter mark.

When using your brakes, notice the amount of pedal travel and braking action. Brakes sometimes become defective while the vehicle is in operation, so give careful attention to the way your brakes work each time you apply them. Remember that when brakes are fully applied, there should be at least a 2-inch clearance between the pedal and the floorboard. If you do not have this 2-inch clearance, a brake adjustment may be needed.

In case your brake pedal "sinks" under constant pressure, make sure you have the hydraulic lines checked for possible leaks. In making a quick stop, note carefully whether the brakes fade or grab. If this happens, the brake linings should be checked to determine if they are worn.

Another point to observe is the way your vehicle steers under operating conditions. Be alert to detect any free play in the steering wheel. Also, notice whether there is any unusual amount of vibration while driving.

Defects discovered during operation should be noted on the Operator's Trouble Report (described later), and reported as soon as operation has ceased. Of course, operation of a vehicle should cease promptly if the operator suspects a deficiency that is a safety hazard or might damage the equipment.

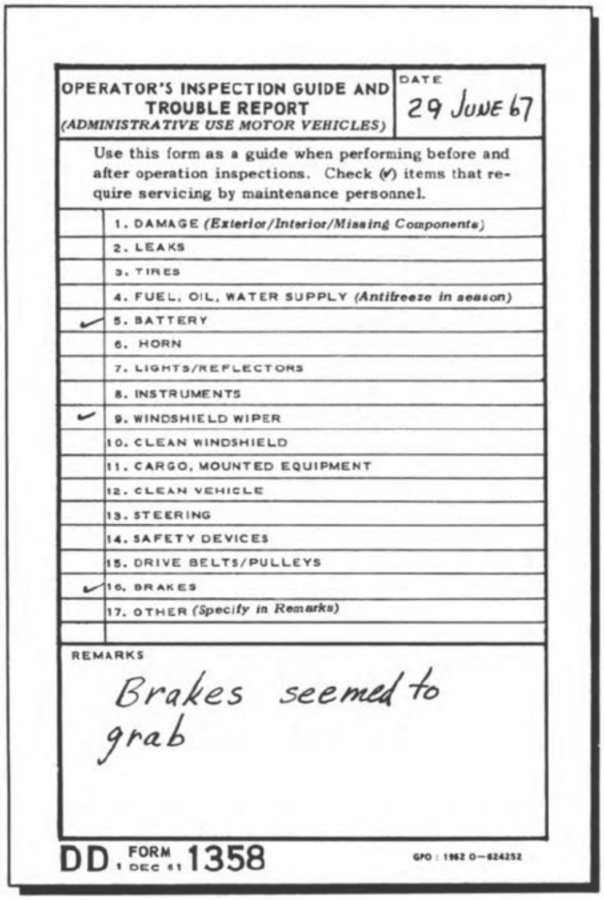
Checks After Operation

When you have finished using a vehicle, check to see that the interior is clean. Use a handbrush, broom, vacuum, or other suitable device for cleaning the upholstery and floors of the vehicle.

Engage the handbrake, unless you are in a location where very cold weather makes it advisable to leave the brake disengaged. Roll up the windows in the vehicle; see that all doors are closed properly; and make sure all tools and wheel-changing equipment are in the proper place.

FORMS

There are several forms with which vehicle operators should be familiar. One of these is the Operator's Inspection Guide and Trouble Report, DD Form 1358. As shown in figure 2-26, the form lists specific items, and the operator indicates by a check mark ($\surd$) those items that are defective or in need of adjustment. A "Remarks" column also is provided in which the operator may enter any useful comments regarding defects. Comments should be brief but complete, since this form will accompany the vehicle to the shop and aid the mechanic in locating the source of trouble.



OPERATOR'S INSPECTION GUIDE AND TROUBLE REPORT (ADMINISTRATIVE USE MOTOR VEHICLES)

DATE: 29 JUNE 67

Use this form as a guide when performing before and after operation inspections. Check (✓) items that require servicing by maintenance personnel.

	1. DAMAGE (Exterior/Interior/Missing Components)
	2. LEAKS
	3. TIRES
	4. FUEL, OIL, WATER SUPPLY (Antifreeze in season)
✓	5. BATTERY
	6. HORN
	7. LIGHTS/REFLECTORS
	8. INSTRUMENTS
✓	9. WINDSHIELD WIPER
	10. CLEAN WINDSHIELD
	11. CARGO, MOUNTED EQUIPMENT
	12. CLEAN VEHICLE
	13. STEERING
	14. SAFETY DEVICES
	15. DRIVE BELTS/PULLEYS
✓	16. BRAKES
	17. OTHER (Specify in Remarks)

REMARKS

Brakes seemed to grab

DD FORM 1 DEC 61 1358 GPO : 1962 O—624252

29.50

Figure 2-26. — Operator's Inspection Guide and Trouble Report, DD Form 1358.

When assigned a vehicle you will be given a written dispatch, known as the Vehicle/Equipment Request and Record, NavFac Form 9-11240/1. This dispatch provides a means for recording vehicle operating data. Also, it is your official authorization for driving a Navy vehicle. (See fig. 2-27.) In case you should be stopped by law enforcement officers while driving an assigned vehicle, a current and properly prepared dispatch would show that you were authorized to drive and have custody of the Navy vehicle.

Before you can operate a Navy vehicle, you must be examined and be issued a license. The license is a U. S. Government Motor Vehicle Operator's Identification Card, Standard Form 46. (See fig. 2-28.) It should be in your possession at all times while driving.

Another form, Operator's Report of Motor Vehicle Accident, Standard Form 91, should be carried in your vehicle at all times. (See figs. 2-29A and 2-29B.) If an accident should occur, see that Standard Form 91 is filled in at the scene of the accident.

AVOIDING ROADSIDE FLATS

One of the most common troubles that vehicle operators experience is FLAT TIRES. In most instances, roadside flats can be avoided if proper precautions are taken.

A careful, systematic check of tire pressures at every service stop will give advance warning of punctures or air leaks. These checks not only help prevent roadside flats but also increase tire life.

As you perhaps know, all inner tubes or tubeless tires may lose air gradually. But what you may not know is that even a punctured tube or tire will generally hold air for days, or even weeks — this happens, for example, if a nail is firmly embedded in the tire.

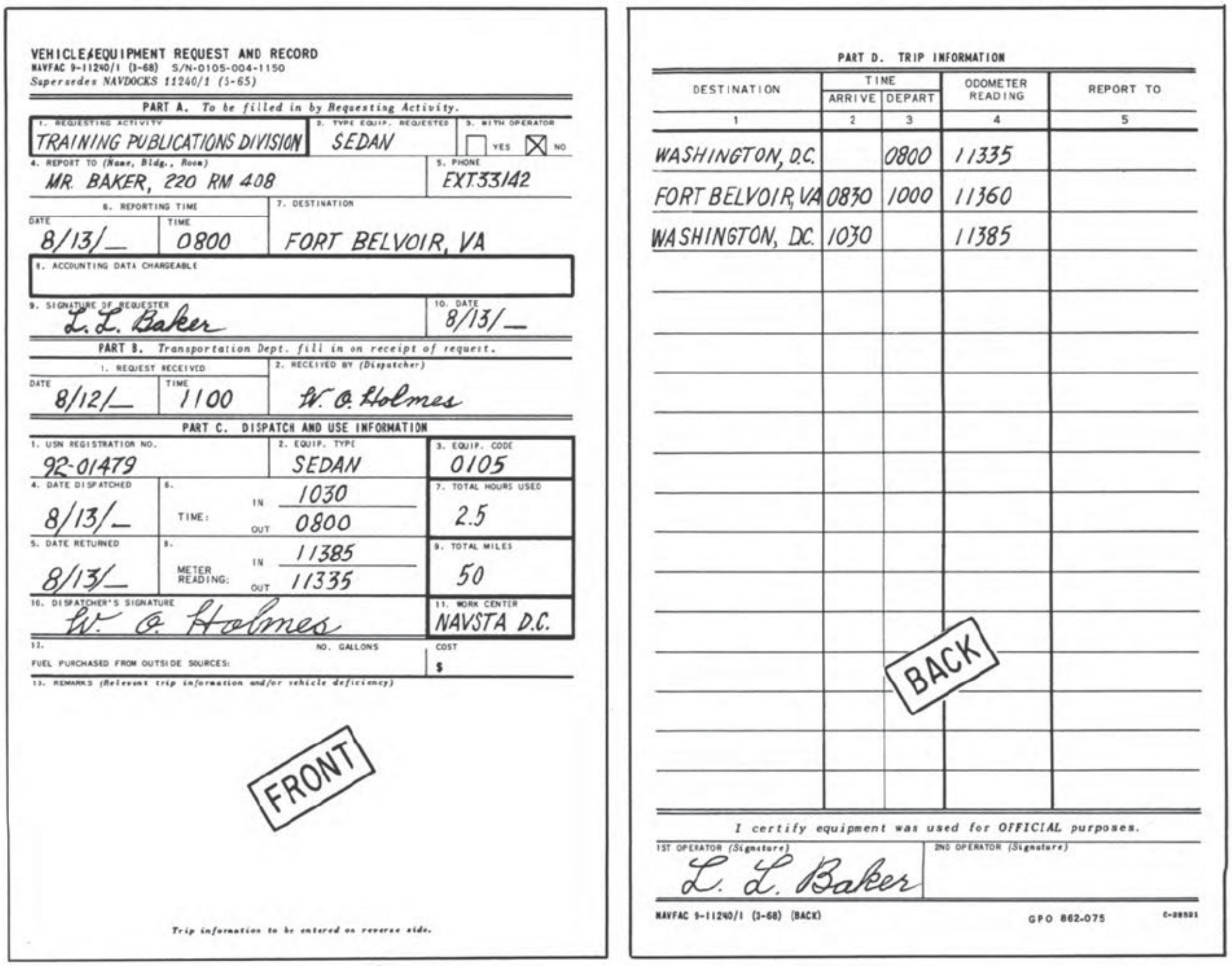
Actually, little air is lost until fatigue breaks down the rubber at the edge of the hole, which, in time, causes excessive loss of air. It is this final break that makes the tire go flat, although the puncture may have occurred several days before. If tires are carefully checked and inspected, punctures often can be detected before the final break that produces a flat tire.

Comparative Air-Loss System

Most roadside flats can be avoided by applying the procedure outlined below. You may hear it referred to as the Comparative Air-Loss System. A point we should stress is that the comparative system is based on the assumption that tires were inflated to specified pressures at the previous check.

VALVE CAPS: Check to make sure each valve cap is screwed on fingertight. And see that each metal valve cap has an air-sealing rubber washer. A loose cap, or one without a rubber washer, permits a leaky valve to reduce tire pressure. If a valve cap is missing from a valve stem, replace the cap immediately.

TIRE PRESSURES: Before adding air, check the pressure in each tire with a tire gage. This



VEHICLE/EQUIPMENT REQUEST AND RECORD
NAVFAC 9-11240/1 (3-68) S/N-0105-004-1150
Supersedes NAVDOCKS 11240/1 (5-65)

PART A. *To be filled in by Requesting Activity.*

1. REQUESTING ACTIVITY: TRAINING PUBLICATIONS DIVISION
2. TYPE EQUIP. REQUESTED: SEDAN
3. WITH OPERATOR: YES ☐ NO ☒
4. REPORT TO (*Name, Bldg., Room*): MR. BAKER, 220 RM 408
5. PHONE: EXT.33142
6. REPORTING TIME: DATE 8/13/__ TIME 0800
7. DESTINATION: FORT BELVOIR, VA
8. ACCOUNTING DATA CHARGEABLE
9. SIGNATURE OF REQUESTER: L. L. Baker
10. DATE: 8/13/__

PART B. *Transportation Dept. fill in on receipt of request.*

1. REQUEST RECEIVED: DATE 8/12/__ TIME 1100
2. RECEIVED BY (*Dispatcher*): W. O. Holmes

PART C. DISPATCH AND USE INFORMATION

1. USN REGISTRATION NO.: 92-01479
2. EQUIP. TYPE: SEDAN
3. EQUIP. CODE: 0105
4. DATE DISPATCHED: 8/13/__
5. DATE RETURNED: 8/13/__
6. TIME: IN 1030 OUT 0800
7. TOTAL HOURS USED: 2.5
8. METER READING: IN 11385 OUT 11335
9. TOTAL MILES: 50
10. DISPATCHER'S SIGNATURE: W. O. Holmes
11. WORK CENTER: NAVSTA D.C.
12. FUEL PURCHASED FROM OUTSIDE SOURCES: NO. GALLONS COST $
13. REMARKS (*Relevant trip information and/or vehicle deficiency*)

FRONT

Trip information to be entered on reverse side.

PART D. TRIP INFORMATION

DESTINATION	TIME ARRIVE	TIME DEPART	ODOMETER READING	REPORT TO
1	2	3	4	5
WASHINGTON, D.C.		0800	11335	
FORT BELVOIR, VA	0830	1000	11360	
WASHINGTON, DC.	1030		11385	

BACK

I certify equipment was used for OFFICIAL purposes.

1ST OPERATOR (*Signature*): L. L. Baker
2ND OPERATOR (*Signature*):

NAVFAC 9-11240/1 (3-68) (BACK) GPO 862-075 C-28521

29.51
Figure 2-27. — Vehicle/Equipment Request and Record, NavFac Form 9-11240/1, front and back.

check should be made when all tires are cool. The reason is that pressure will vary with the temperature of each tire, and all tires may not be heated to the same extent. The gage readings of hot tires may be misleading with regard to a comparative air-loss test.

PUNCTURE INDICATIONS: Variations in tire pressure, as shown below, may indicate punctures. Slight variations in pressure can be expected. But when valve caps are on fingertight, consider the following differences in pressure as an indication of punctures:

1. Any passenger tire that is 3 pounds below the lowest of its running mates probably has a puncture.

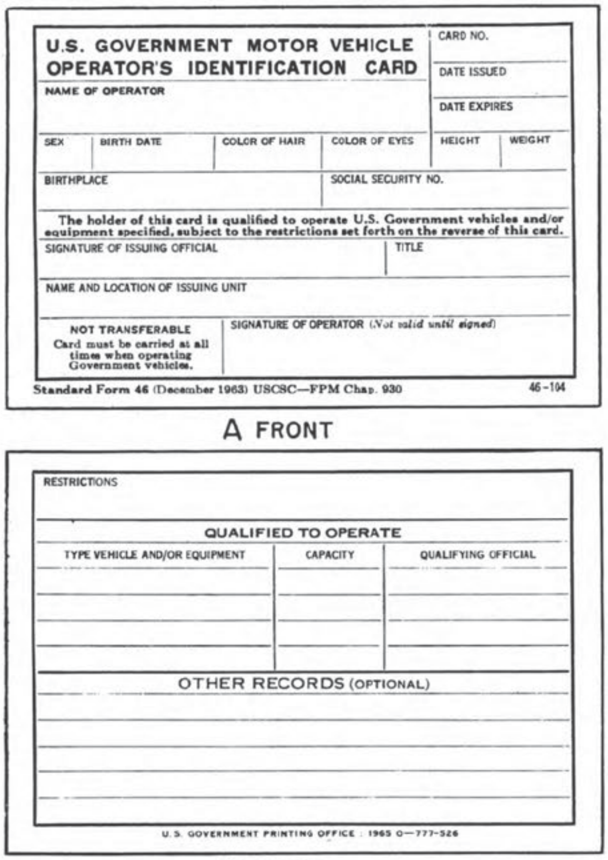
2. Any truck or bus tire 5 pounds below its running mates is likely to have a puncture.

3. Any tire showing a loss of more than 5 pounds should be removed for examination and repaired as required.

TIRES CONSIDERED IN GOOD CONDITION: Add air, if needed, to bring each tire to its specified air pressure.

RUBBER WASHERS: Make sure the rubber washer in each valve cap is not damaged. Screw the cap on fingertight to avoid loss of air at the valve.

FINAL AIR-LOSS TEST: When foreign objects are removed from a tire tread, make a comparative air-loss test or immerse the tire in



U.S. GOVERNMENT MOTOR VEHICLE OPERATOR'S IDENTIFICATION CARD

CARD NO.

DATE ISSUED

DATE EXPIRES

NAME OF OPERATOR

SEX | BIRTH DATE | COLOR OF HAIR | COLOR OF EYES | HEIGHT | WEIGHT

BIRTHPLACE | SOCIAL SECURITY NO.

The holder of this card is qualified to operate U.S. Government vehicles and/or equipment specified, subject to the restrictions set forth on the reverse of this card.

SIGNATURE OF ISSUING OFFICIAL | TITLE

NAME AND LOCATION OF ISSUING UNIT

NOT TRANSFERABLE
Card must be carried at all times when operating Government vehicles.

SIGNATURE OF OPERATOR (*Not valid until signed*)

Standard Form 46 (December 1963) USCSC—FPM Chap. 930 46-104

A FRONT

RESTRICTIONS

QUALIFIED TO OPERATE

TYPE VEHICLE AND/OR EQUIPMENT	CAPACITY	QUALIFYING OFFICIAL

OTHER RECORDS (OPTIONAL)

U. S. GOVERNMENT PRINTING OFFICE : 1965 O—777-526

B BACK

115.45

Figure 2-28.—U. S. Government Motor Vehicle Operator's Identification Card, Standard Form 46.

water and observe for air bubbles which indicate air loss. If time permits, it is recommended that several hours be permitted to elapse between the removal of the foreign object and the air-loss test. If an object has pierced the inner tube, or the casing of a tubeless tire, removal of the object unplugs the hole and changes a slow leak to a fast leak.

Air Pressure

Charts showing the tire manufacturer's recommended inflation pressures and rated carrying capacity for all sizes of tires commonly used for transportation vehicles should be posted at all air-pressure checking outlets. Check these charts if you are not sure of the pressure required for tires of a particular vehicle assigned to you.

SAFETY ON THE ROAD

A point deserving strong emphasis is that a GOOD driver is a SAFE driver. There are many factors that have a bearing on safety in operating a vehicle. This phase of our discussion will brief you on some of the major factors; for instance, traffic signs, arm signals, overtaking and passing, and following other vehicles.

Before proceeding, however, we should point out that you may find slight variations in the shape, color, and meaning of traffic signs in different states or localities. You may also find some differences in speed limits, signal lights, driving regulations, and so on, in various places throughout the nation or bases where you are stationed. Keep in mind, therefore, that the information in this discussion is general and should be used primarily as a guide. In most places, the signs, signals, and practices may be the same or similar to those described here. But always check the regulations and practices for your particular area for the specific details to follow.

Traffic Signs

Traffic signs are erected to warn and to guide the motorist. In addition to its words or symbols, the shape and color of a traffic sign usually have particular meanings. In the interest of your own personal safety, you should become familiar with the shapes, colors, and general meanings of traffic signs. Then you will have a pretty good idea of the message conveyed by a sign, even though rain or fog should make it difficult to distinguish the lettering or symbol. Some of the common types of signs used to regulate a driver's movement or to warn of potential hazards ahead are illustrated in figure 2-30.

OCTAGONAL SIGNS.—Stop signs are octagonal (eight-sided) in shape and the word STOP appears in large letters. Usually the background of stop signs is either red or yellow in color. A stop sign means that you must bring your vehicle to a COMPLETE STOP, not just a rolling stop.

TELL IN YOUR OWN WAY HOW ACCIDENT HAPPENED

I was heading southwest on Nichols Avenue between "V" and "W" streets, S.E. and as I was proceeding along the street the other vehicle pulled out of a parking spot. He hit my right rear fender with his left front fender.

The man driving the Plymouth said that he was at complete fault because he did not look before pulling out.

SIGNATURE: Ronald Logan — DATE: 1/20/67

HAVE YOU ANSWERED ALL QUESTIONS ...Y AS POSSIBLE?

U. S. GOVERNMENT PRINTING OFFICE 9—11—67400-1

THIS FORM TO BE FILLED OUT BY THE GOVERNMENT OPERATOR AT THE TIME AND AT THE SCENE OF THE ACCIDENT, INSOFAR AS POSSIBLE.

OPERATOR'S REPORT OF MOTOR-VEHICLE ACCIDENT

DEPARTMENT OR AGENCY: U.S. NAVY

NAME AND LOCATION OF ORGANIZATION TO WHICH YOU ARE ASSIGNED: U.S.N.S., Wash. (20025) D.C.

I OPERATOR

PLEASE PRINT FULL NAME: Ronald Logan — RANK, RATING, OR TITLE: SN

SERVICE NUMBER OR ROSTER TITLE: 700-00-01 — OPERATOR'S STATE PERMIT NUMBER: 351-54

HOME ADDRESS (Street, city, State): 1510 Key Blvd, Arlington, Va. — TELEPHONE (Home): OL. 3-8960

II TIME AND PLACE

DATE AND DAY OF WEEK OF ACCIDENT: January, 1967 (Wed) — HOUR (A.M. or P.M.): About 1:30 (P.M.)

PLACE OF ACCIDENT (If accident in city, give city and State; if outside city limits, indicate mileage to nearest city or other landmark.): Washington, D.C.

FROM WHAT PLACE TO WHAT PLACE WERE YOU BOUND: U.S.N.S. to Main Navy

FOR WHAT PURPOSE: Guard Mail Run

III YOUR VEHICLE

MAKE: Chev. — TYPE: 1959 — REGISTRATION NUMBER OR OTHER IDENTIFICATION: 91-00380

PARTS OF VEHICLE DAMAGED (Describe): Right Rear Fender

IV OTHER VEHICLE AND PROPERTY (For additional vehicles see page 2)

MAKE: Plymouth — TYPE: Sedan — YEAR: 1967

OPERATOR'S STATE PERMIT NUMBER: 57024 — VEHICLE LICENSE NUMBER: A-1450

OPERATED BY (Name): Arthur Jones — VEHICLE OWNED BY: Arthur Jones

OPERATOR'S HOME ADDRESS (Street, city, State): 6773 Lanham Lane, Wash DC — OWNER'S ADDRESS (Street, city, State): 6773 Lanham Lane, Wash, DC

PARTS OF VEHICLE DAMAGED (Describe): Left Front Fender

OTHER VEHICLE OR PROPERTY DAMAGED (Describe): None

Standard Form 91
Revised Aug. 1952

BUREAU OF THE BUDGET
Circular A-5 (Rev.)

FRONT

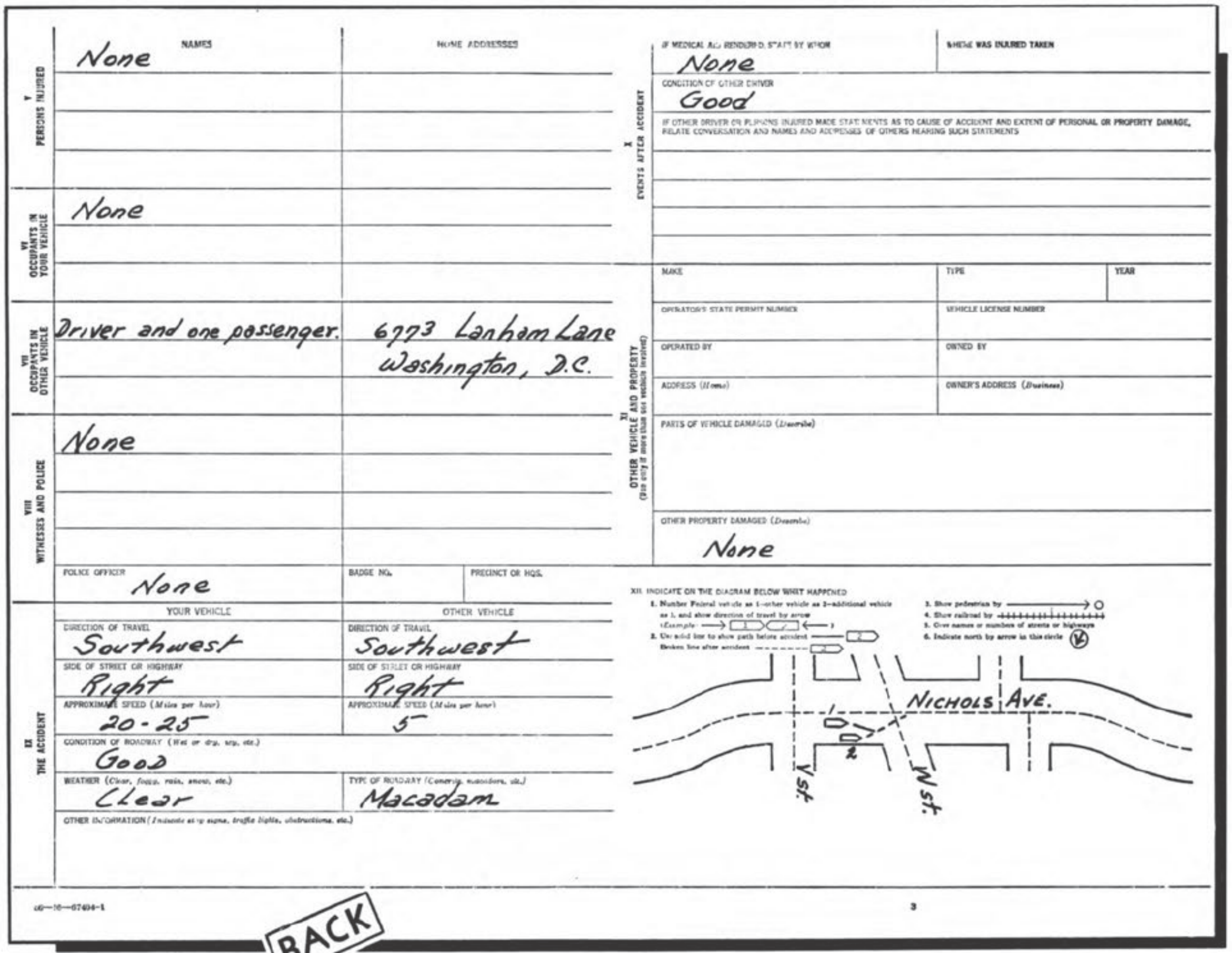
29.52.1
Figure 2-29A.—Operator's Report of Motor Vehicle Accident, Standard Form 91 (front).

SQUARE-SHAPED SIGNS.—You should recognize square-shaped signs as meaning CAUTION. These signs are used to warn of school zones, road work, slippery roads, and similar areas or conditions (fig. 2-30). Caution signs are white or yellow, with block lettering or figures.

DIAMOND-SHAPED SIGNS.—Diamond-shaped signs, which are yellow, mean to REDUCE SPEED. (See fig. 2-30.) These signs are used to warn drivers of hills, a winding stretch of road, and other physical hazards that require a reduction in speed for safety.

TRIANGULAR-SHAPED SIGNS.—In many instances you will find YIELD RIGHT-OF-WAY signs at intersections, or they may just say YIELD. These signs, which are triangular-shaped, mean to yield the right-of-way to traffic in or approaching the intersection. A point well worth remembering is to yield the right-of-way until the road is sufficiently clear for you to pull out into the intersection.

ROUND AND OBLONG SIGNS.—SPEED LIMIT signs are usually round or oblong. A speed limit sign tells you the highest speed considered safe under good traffic conditions when the roadway is dry. Often bad weather, heavy traffic, or other unfavorable factors make it advisable to drive at a lower speed than posted on the speed limit signs. Reduce speed at night, in wet



V PERSONS INJURED

NAMES	HOME ADDRESSES
None	

VI OCCUPANTS IN YOUR VEHICLE

None	

VII OCCUPANTS IN OTHER VEHICLE

Driver and one passenger.	6773 Lanham Lane Washington, D.C.

VIII WITNESSES AND POLICE

None	

POLICE OFFICER	BADGE NO.	PRECINCT OR HQS.
None		

IX THE ACCIDENT

	YOUR VEHICLE	OTHER VEHICLE
DIRECTION OF TRAVEL	Southwest	Southwest
SIDE OF STREET OR HIGHWAY	Right	Right
APPROXIMATE SPEED (Miles per hour)	20-25	5

CONDITION OF ROADWAY (Wet or dry, icy, etc.) Good

WEATHER (Clear, foggy, rain, snow, etc.) Clear

TYPE OF ROADWAY (Concrete, macadam, etc.) Macadam

OTHER INFORMATION (Indicate stop signs, traffic lights, obstructions, etc.)

X EVENTS AFTER ACCIDENT

IF MEDICAL AID RENDERED STATE BY WHOM None

WHERE WAS INJURED TAKEN

CONDITION OF OTHER DRIVER Good

IF OTHER DRIVER OR PERSONS INJURED MADE STATEMENTS AS TO CAUSE OF ACCIDENT AND EXTENT OF PERSONAL OR PROPERTY DAMAGE, RELATE CONVERSATION AND NAMES AND ADDRESSES OF OTHERS HEARING SUCH STATEMENTS

XI OTHER VEHICLE AND PROPERTY (Use only if more than one vehicle involved)

MAKE	TYPE	YEAR
OPERATOR'S STATE PERMIT NUMBER	VEHICLE LICENSE NUMBER	
OPERATED BY	OWNED BY	
ADDRESS (Home)	OWNER'S ADDRESS (Business)	

PARTS OF VEHICLE DAMAGED (Describe)

OTHER PROPERTY DAMAGED (Describe) None

XII INDICATE ON THE DIAGRAM BELOW WHAT HAPPENED

29.52.2

Figure 2-29B. — Operator's Report of Motor Vehicle Accident, Standard Form 91 (back).

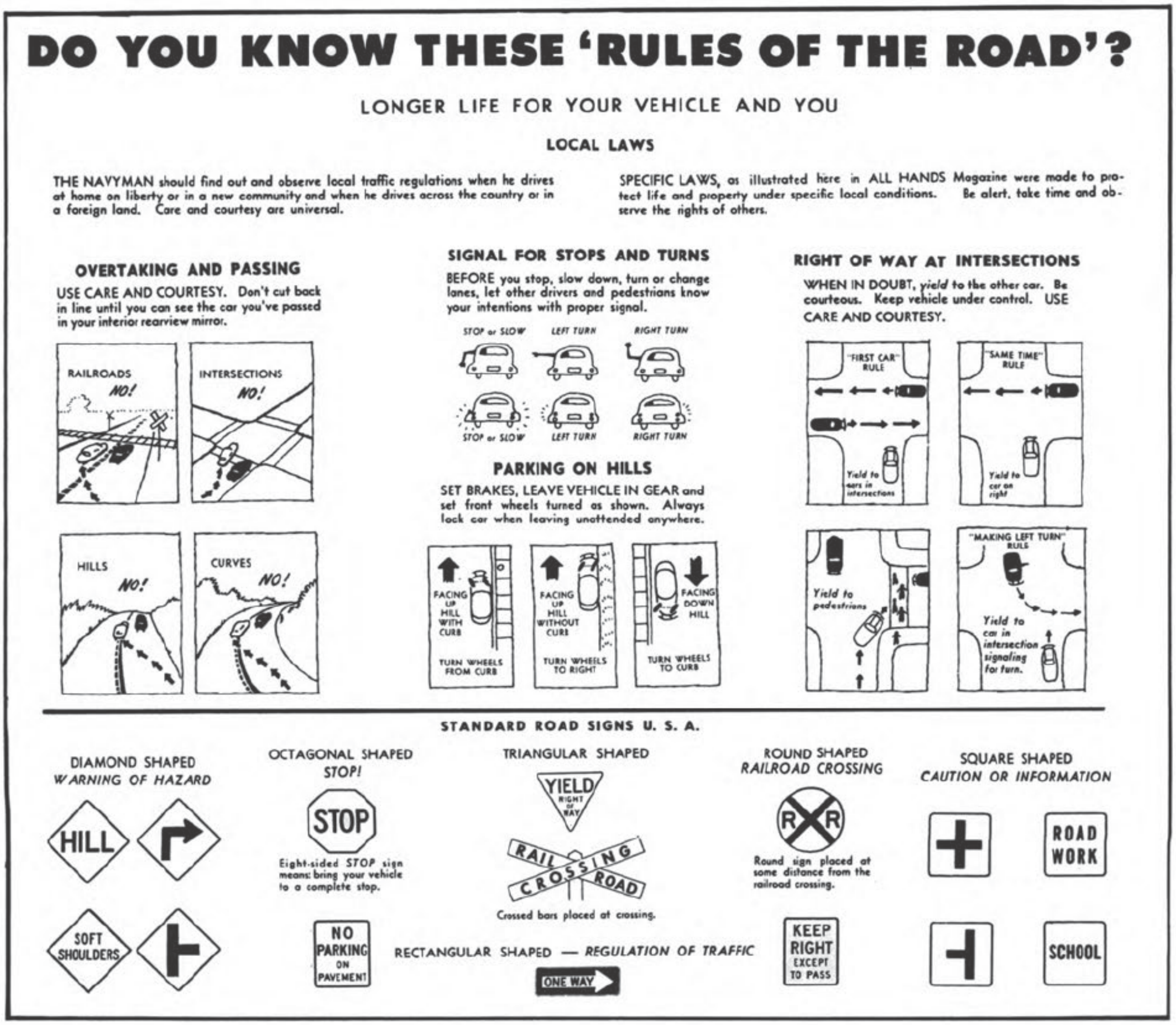
weather, in snow, on bad roads, and whenever other such conditions warrant.

Two types of railroad crossing signs are commonly used. A round or a square sign with a cross is placed some distance from the railroad crossing to give advance warning; the familiar "cross buck" sign is located at the crossing. (See fig. 2-30.) These signs warn drivers to watch for trains from each direction and to be prepared to stop.

REMINDER: Bear in mind that traffic signals, road markings, and other similar aids provide the same general information as traffic signs. Make sure you become familiar with and observe all such aids — as well as traffic signs — applicable to your particular area.

INTERNATIONAL ROAD SIGNS. — A knowledge of international road signs might be useful to SEABEES who are deployed overseas. Some of the important signs are shown in figure 2-31. The wording of the sign, of course, will be in a foreign language; you must be able to determine the meaning from the shape of the sign and from the markings on it.

GUIDE SIGNS. — Guide signs or markers are erected along the highway to provide the motorist with various types of useful information. Figure



29.53

Figure 2-30.— United States standard traffic signs.

2-32 illustrates some of the common types and shapes of guide signs.

Guide signs tell the motorist the route he is traveling, the town he is approaching, and so forth. On long trips, particularly, most drivers give special attention to distance signs. These signs are located on major state routes at the corporation limits of cities or towns and at junctions of state highways to give the distance to the next incorporated town and the next large city.

Arm Signals

Arm signals should be given for turns and stops so that other drivers, as well as pedestrians, will know what you intend to do. Hand signals, as required in most States, are illustrated in figure 2-33. In a few States you will find slight variations from the signals given here, so check the requirements of the State in which you are located.

When signaling for a stop or turn, hold the signal long enough to ensure that your intentions are clearly understood. Here are directions for making the arm signals shown in the illustration (fig. 2-33). For a RIGHT TURN, extend your left forearm at a 90-degree angle above the horizontal. Some localities require that the hand be moved in a small circle. To signal a LEFT turn, extend your left arm straight out horizontally. In some places, pointing with the finger may also be required. For STOPPING or SLOWING DOWN, extend your left forearm out and point it down toward the ground.

Instead of arm signals, mechanical directional lights may be used if your vehicle is so equipped and this method of signalling is acceptable in the area in which you are driving.

Speed Limits

Speed regulations should be observed at all times. Since speed limits often differ from one locality to another, make sure you become familiar with the speed limits for the area in which you are located. Watch your speedometer and check the speed limit signs by the roadway so that you will not exceed the highest speed allowed. For your own safety, and the safety of others as well, never drive at a speed that is unreasonable or reckless.

Be alert to recognize conditions that call for a reduction in speed. Sometimes road conditions, type of vehicle, poor visibility, or heavy traffic will make it advisable to drive below the highest speed posted for the area. Other conditions that may require a reduction in speed are as follows:

1. Approaching and crossing an intersection or railway grade crossing.
2. Approaching a drawbridge or lift bridge.
3. Approaching and going around a curve.
4. Approaching a hill crest.
5. Traveling on any narrow, winding roadway.
6. Driving on a wet pavement, over snow or ice, or through rain, snow, sleet, fog, mist, dust, or smoke.

It is especially important that you remember to exercise special care when driving past schools or playgrounds. Be prepared to make a quick, emergency stop in the event a child should dash unexpectedly into the road ahead of your vehicle. You never know when a child is going to dart out into the street chasing a ball or running to meet a playmate, and without thinking to check for traffic beforehand. (See fig. 2-34.) If you are not driving with enough care to avoid any possibility of hitting a child, you are not driving safely.

Driving in Proper Lane

Most traffic regulations require that vehicles drive in the right-hand lane and pass on the left. On some multiple-lane highways, however, passing on either side is permitted. Keep in one lane except when passing or changing lanes in preparation for a turn. (See fig. 2-35.) In heavy traffic, stay in one lane and proceed at the normal pace of the traffic.

Turning

To avoid accidents while turning, make it a practice to DECIDE where you want to turn before you get there. Another precaution is to SIGNAL the turn you intend to make well ahead of the turn-off point; also, hold the signal until you are near enough to the point of turning to make sure your intentions are clearly understood. You must also move your vehicle into the proper lane some distance before reaching the turn-off point. In addition, CHECK the traffic that may be following you before changing lanes and before making the turn.

On two-lane streets or highways, start and end ALL TURNS in the right lane. Figure 2-36 illustrates a good method for making a right turn and a left turn on a two-way street.

On streets or highways with four or more lanes, RIGHT turns should start and end in the extreme right lane; LEFT turns should start and end in the lane just to the right of the centerline. On a three-lane road, a LEFT turn should be made from the center lane.

When making a right turn, keep as close as possible to the right edge of the roadway. A left turn should be made to the left of the center of the intersection if practicable, unless the intersection is marked differently with lines or buttons.

Now suppose you are on a divided highway and want to turn left so that you can travel in the opposite direction. To do so, approach the

C29.53.1
Figure 2-31. — International traffic signs.

1 Dangerous bend
2 Right bend
3 Double bend
4 Intersection
5 Intersection with a non-priority road
6 Opening bridge
7 Level-crossing with gates
8 Level-crossing without gates
9 Low flying aircraft
10 Traffic signals ahead
11 Road works
12 Pedestrian crossing
13 Children
14 Beware of animals
15 Animals crossing
16 Road narrows
17 Uneven road
18 Dangerous hill
19 Slippery road
20 Quay or river bank
21 Merging traffic
22 Roundabout ahead
23 Two-way traffic
24 Danger
25 Danger from falling rocks
26 Loose chippings
27 Priority road ahead
28 Stop at intersection
29 Closed to all vehicles
30 No entry for all vehicles
31 No entry for all motor vehicles except motorcycles without sidecars
32 No entry for motorcycles without sidecars
33 No entry for all motor vehicles
34 No entry for pedal cyclists
35 No entry for goods vehicles exceeding...tons laden weight
36 No entry for vehicles having overall width exceeding... metres
37 No entry for vehicles having overall height exceeding ...metres
38 No entry for vehicles having overall length exceeding ...metres
39 No entry for vehicles exceeding...tons laden weight
40 No entry for vehicles having an axle weight exceeding...tons
41 Closed to all motor vehicles drawing a trailer other than a semi-trailer or a single-wheel trailer
42 Closed to lorries drawing a trailer
43 Closed to pedestrians
44 No left (or right) turns
45 No U turns
46 Overtaking prohibited
47 Overtaking by lorries prohibited
48 End of prohibition
49 Speed limit
50 Speed limits for light and heavy motor vehicles
51 End of speed limit
52 End of speed limit
53 Use of horn prohibited
54 Priority to be given to vehicles coming in the opposite direction
55 Stop: Customs
56 No parking – on left on uneven dates; on right on even dates
57 No parking
58 Stopping prohibited
59 Direction to be followed
60 Roundabout
61 Compulsory cycle track
62 Compulsory minimum speed
63 Compulsory way for pedestrians

29.53.2

Figure 2-31. — Legend for international traffic signs.

crossover in the extreme left-hand lane that you may lawfully use. Then complete your left turn, traffic permitting, so that you will leave the crossover and enter in the left-hand lane being used by traffic moving in the direction you desire to travel.

Intersection Right-of-Way

A great number of accidents occur at intersections. Upon approaching an intersection always have your vehicle under complete control. Be prepared to stop in time to avoid a possible accident with another vehicle or injury to a pedestrian.

At an intersection where there are no stop signs, yield right-of-way signs, police officer, or traffic signals, you must yield the right-of-way to vehicles approaching from your right. Just remember, "from the right has the right."

You should yield the right-of-way to a vehicle making a left turn across your lane if the vehicle has started to turn before you reach the intersection. Remember that pedestrians have the right-of-way at an unprotected crossing. Give it to them willingly!

When you are in doubt as to the right-of-way, YIELD to other traffic. But even when you are certain the right-of-way is yours, make sure the other drivers are going to stop or yield the right-of-way to you. If a driver insists

29.54
Figure 2-32. — Guide signs.

on taking the right-of-way when it is yours, remember that it is better to yield than risk having an accident.

Overtaking and Passing

The exercise of sound judgment is essential to safety in overtaking and passing other vehicles. Do not overtake and pass another vehicle on a hill, on a curve, at or near an intersection or crossroad, at or near a railroad crossing, or within 100 feet of a bridge. (See fig. 2-37.) When driving on a road that has both a broken line and a solid line, DO NOT overtake a vehicle when the solid line is on your side of the centerline. As a reminder, DO NOT overtake and pass a vehicle at any place where you do not have plenty of distance and time to pass and get back on your side of the road without crowding.

When outside of business or residential districts, sound your horn to signal the driver ahead that you are about to pass. Flick your lights also, at night, since the driver ahead may not hear the horn. Of course, you should always give a left signal before pulling into the left lane to pass a vehicle, and then give a right signal before pulling back into the right lane.

Don't take chances in passing! The roadway ahead should be clearly visible and free of oncoming traffic for a sufficient distance to ensure complete passing. Know the acceleration capabilities of your vehicle. Also, watch for oncoming traffic and move back to your side of the road promptly, first making sure you are safely clear of the other vehicle.

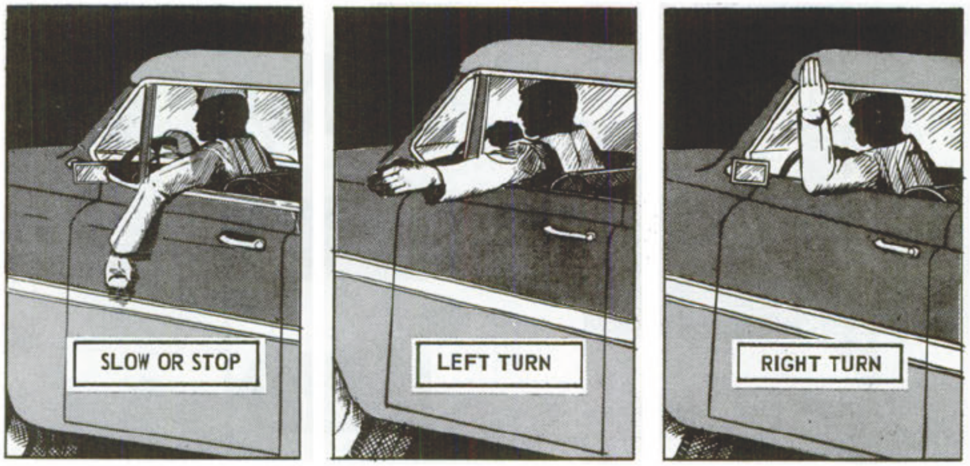
Following Other Vehicles

The distance at which it is safe to follow a vehicle ahead of you depends upon various factors, such as the speed of the other vehicle, weather conditions, the road, and your alertness and reaction time. You never know when a vehicle in front of you is going to stop quickly without sufficient warning in advance. With that in mind, make allowance for reaction time in judging the safe distance to follow a vehicle. As a guide, allow at least 1 car-length, between your vehicle and the one ahead, for each 10 miles of speed.

When following a heavy truck or truck-and-trailer combination, allow yourself an extra margin of space for stopping since these units have extremely good traction and brakes and can stop in a short distance. When following fire apparatus answering an alarm, or other emergency vehicles, keep your vehicle at least 500 feet to the rear.

Night Driving

When driving at night, reduce your speed to such an extent that you would be able to stop within the distance you are clearly able to see

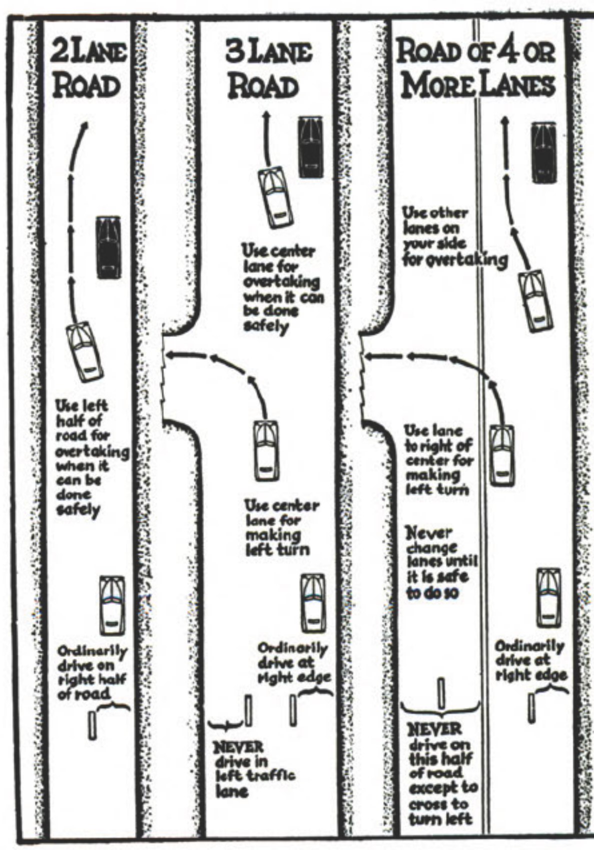


29.55
Figure 2-33.—Arm signals.

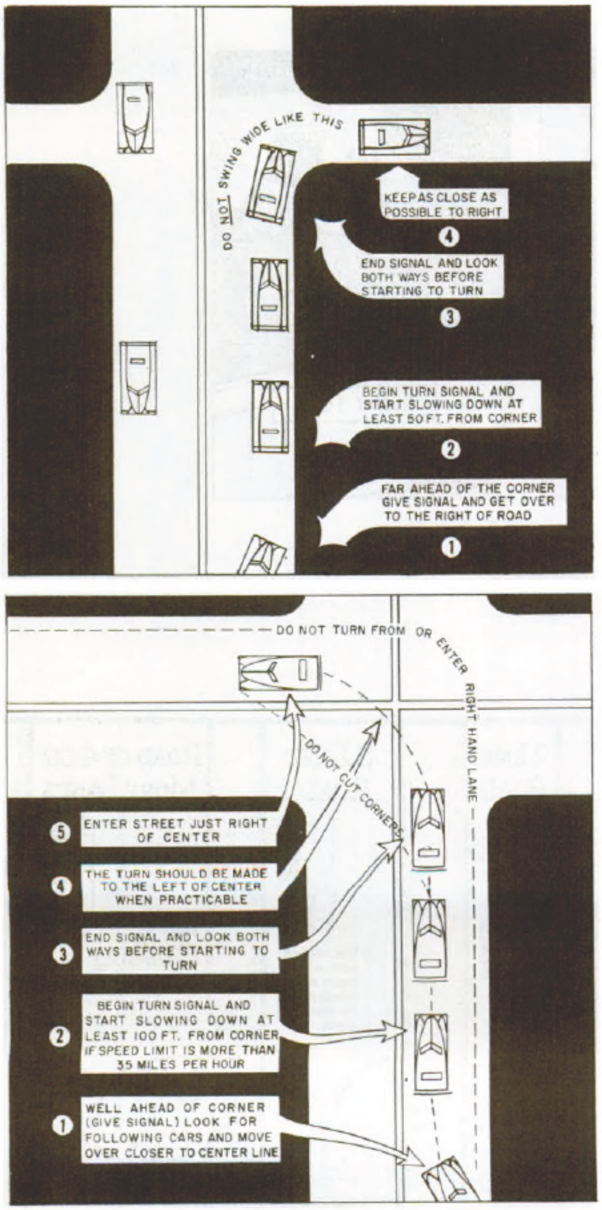
29.56
Figure 2-34.—Be careful of children.

with your headlights. Dim your headlights in residential or business areas and when meeting or passing another vehicle.

Many accidents happen between sunset and dark. A main reason for this is that it is difficult to see clearly during these hours. As a safety precaution, headlights should be turned on one-half hour before sunset to one-half hour after sunrise, and at other times during daylight hours when there is not sufficient light to see clearly.



29.57
Figure 2-35.—Drive in proper lane.



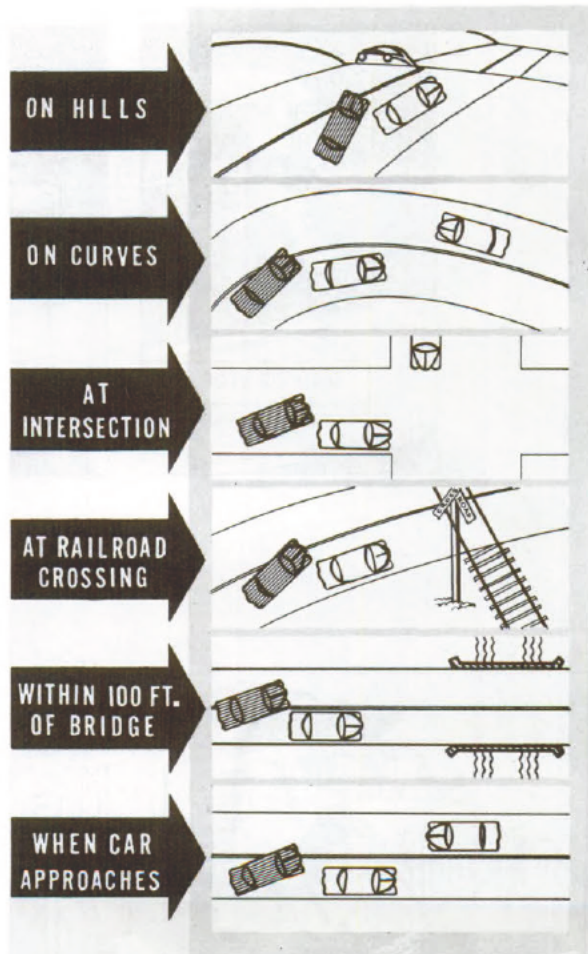
29.58X

Figure 2-36.—Learn to make turns properly.

Bad-Weather Driving

The accident risk is increased by hazardous weather conditions such as rain, sleet, fog, ice, and snow. A few suggestions for driving in bad weather are given below.

In rain, sleet, snow, and the like, always adjust the speed of your vehicle to existing conditions. Chains add to traction in starting and stopping in heavy snow, soft ice, and mud. But even with chains, reduced speeds and additional care are necessary in slippery weather. Bear in mind that tire chains are only a traction aid; chains do not eliminate the hazardous conditions caused by bad weather. Chains should be put on when they will give added traction and safety, and removed when clear pavement is reached.



29.59X

Figure 2-37.—Locations where you should not pass another vehicle.

Keep the outside of the windshield and windows clear of snow, ice, and frost at all times, and use the vehicle defroster to improve visibility. Use extreme caution when driving in fog. Follow other vehicles at a safe distance. Remember that control of the vehicle and distances required

to stop are not the same in bad weather as in good weather.

Apply brakes with a light pumping action to prevent skidding. Give signals for stops and turns, and make them well enough in advance so that traffic following you will clearly understand your intentions.

In case of skidding, try to steer your vehicle in the direction of the skid. Sometimes speeding up slightly will also aid in getting the vehicle back under control. Do not disengage the clutch. Do not apply the brakes as they lock the wheels.

Stopping

As pointed out earlier, stop signs require that you bring your vehicle to a complete stop. There are a number of other conditions where this same rule applies, as follows:

Stop when approaching a flashing red light or a sounding siren (fire, emergency, or police vehicle).

Stop when the amber caution light flashes on a traffic signal if you can do so safely. You may continue if the light becomes amber WHILE YOU ARE IN THE INTERSECTION.

Stop when a streetcar has stopped to receive or discharge passengers; where there is no loading or safety zone, stop BEHIND the streetcar.

Stop at railroad crossings on the flagman's signal or where the red warning lights are flashing, or where it is otherwise indicated that the crossing is not clear.

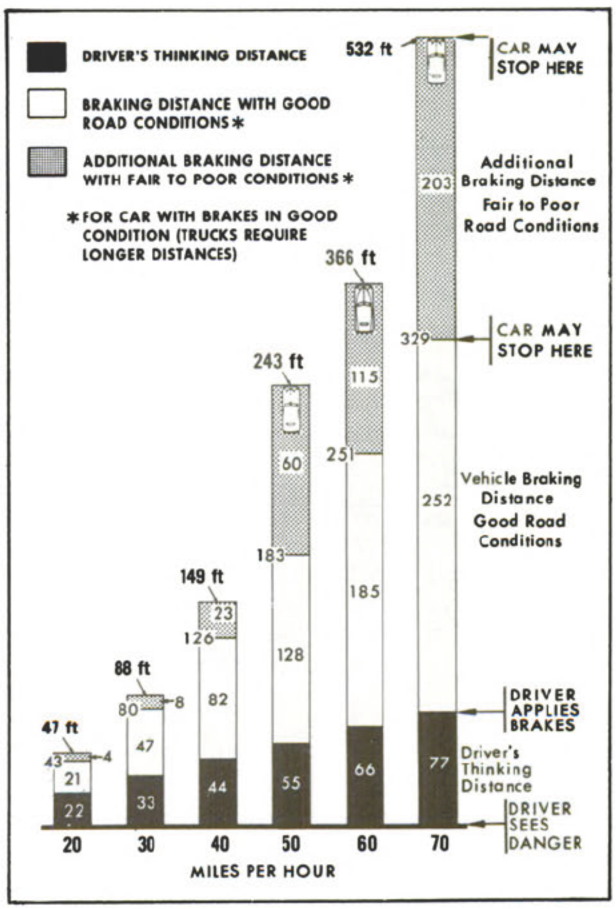
Stop when overtaking or meeting a school bus that has stopped to receive or discharge school children. (This varies for different States—check the regulation of the State in which your activity is located.)

Stopping Distances

It takes a great deal more braking power and requires much more distance to slow a vehicle from 50 to 40 miles per hour than it does from 30 to 20 miles per hour. A careless driver who is unaware of required stopping distances is likely to take curves at too high a rate of speed or follow too closely behind vehicles moving at high speeds. Vehicle brakes cannot be applied instantly. For safety on the road, it is important to have some idea of the distance your vehicle will travel from the time you see danger, take your foot off the accelerator and depress the brake pedal until the brakes actually take effect, and the car stops. Give some study to the illustration in figure 2-38; it shows you some stopping distances obtained from scientific tests.

Pulling off the Road

If you have a flat tire, make sure you pull off a safe distance on the side of the road to change to the spare. Sometimes you may have only a narrow shoulder of road on which to park for this emergency. It is wise, in that case, to give a warning with your flasher signal—if your vehicle is so equipped—while changing the tire. The blinking turn signal will serve as a caution signal to warn oncoming drivers; hence, it is a valuable safety measure.



2.131
Figure 2-38.—Speed as a factor of stopping distance.

Backing Safety

As you know, not all driving is forward. You may have to back into loading platforms and into or out of parking spaces. You should be extra careful in backing out of a parking space, especially in residential areas. Numerous cases have been recorded about children being fatally injured as a result of backing Navy vehicles. To minimize these occurrences, some Commanding Officers put out regulations requiring Navy truck drivers to walk behind their vehicles before getting inside to make sure that nobody is behind or under them. In a tight space, and where the rear view of your vehicle is limited, have someone direct you; otherwise, get out frequently to check whether the way is clear.

At present, some Navy vehicles and construction equipment are equipped with a back-up alarm system. The alarm provides a loud and clear warning, usually a ringing bell very similar in sound to manually operated bells installed on fire engines. This alarm alerts any person behind your vehicle while you are backing up. However, you should bear in mind that this type of alarm system will be effective only to persons who are capable of understanding the danger signal. It will not work for toddlers; therefore, checking behind your vehicle at all times before backing up is imperative.

Courtesy

Operators of Navy vehicles are expected to practice "courtesy on the road" at all times towards other drivers, as well as towards pedestrians. Courtesy is a mark of the efficient and safe driver. The driver who practices courtesy on the road also is helping prevent accidents with other vehicles and injuries to pedestrians.

You have probably seen many examples of discourtesy on the road. Common traits often displayed by discourteous drivers include impatience, road hogging, excessive speed, and so forth. A person with such characteristics may have a lot of knowledge of driving, but it takes more than knowledge where safety is concerned. To achieve a good safety record, a driver must practice courtesy on the road at all times.

A courteous driver makes allowance for lack of skill and experience by other drivers. He also learns to recognize accident-producing situations far enough in advance to take action that will prevent them from happening. He is willing to give in to other drivers in such matters as yielding right-of-way rather than risk an accident. Among other things, the courteous driver is aware of his responsibilities, and shows proper respect for driving regulations and the rights of others.

Driver Fatigue

Continuous driving frequently results in driver fatigue; that is, physical and mental tiredness due to sitting a long time at the wheel. If a driver is overtired, he may doze at the wheel, and if the vehicle should go out of control, a serious or fatal accident may occur.

As a safety measure, drivers should take breaks or rest stops — when becoming fatigued or sleepy. After parking the vehicle, get out and walk around in order to stretch your muscles. Rest stops are especially important when on a long trip requiring many hours of driving.

Navy Driver's Handbook

If you would like to do some studying on your own, an excellent reference is the Navy Driver's Handbook, NavFac MO-403. This publication provides operating instructions for starting the engine, using the clutch, shifting gears, and so forth. Information is presented in MO-403 on general driver requirements, rules of the road, and other topics that will aid you in maintaining a high degree of driving efficiency.

CHAPTER 3

CONSTRUCTION EQUIPMENT

This chapter will introduce you to some of the various types of construction equipment used by the SEABEES to accomplish various construction jobs. It includes earthmoving equipment used in preparing sites for construction of buildings, piers, roadways, airfields, and the like. Rock crushers, asphalt plants, and asphalt paving equipment are among other types of construction equipment which also are covered.

It is well to note that the operation of this equipment is the job of the Equipment Operators — NOT the Constructionman. For this reason, instructions and detailed procedures on the operation of this equipment are not provided in this discussion. Instead, we are primarily interested in special features or identifying characteristics of certain basic types of equipment, special uses, and safety precautions to be observed when working around the equipment.

It is not possible to cover all the construction equipment used by the SEABEES in this chapter alone. The equipment to be covered in this chapter is that which is generally under the cognizance of the Equipment Operators. Other construction equipment, such as that used in concrete construction, steelworking, and so on, will be covered later in appropriate chapters.

As a Constructionman, you may perform certain basic duties as a helper to Equipment Operators on various construction projects; therefore, you will find it beneficial — both now and later — to be able to recognize common types of construction equipment and know the kinds of work done by each. Some of the duties which you may perform are considered in this chapter.

EARTHWORK EQUIPMENT

This section will introduce you to some of the common types of equipment used in earthwork operations. Remember that our main interest is with special features or characteristics of particular types of earthwork equipment and the kinds of work each type can do.

TRACTORS

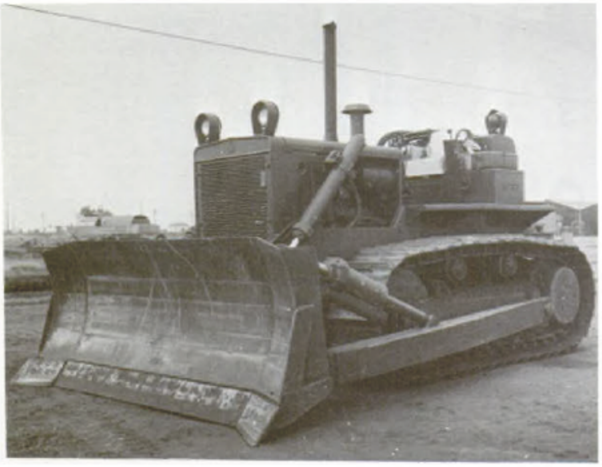
A tractor may be used simply as a PRIME MOVER, to push or tow another item of construction equipment (a bowl scraper, for example). Or, it may be used as a self-contained piece of construction equipment, in which case it is rigged with one of several types of attachments, such as a dozer blade or front-end loader. Both wheel- and crawler-type tractors are available. The Navy uses tractors made by most of the well-known American manufacturers, such as Caterpillar, International Harvester Company, Allis-Chalmers, and others.

Crawler-Type Tractors

The CRAWLER (or TRACKLAYING) type of tractor is mounted on a pair of endless tracks made up of a series of interlocking treads. Crawler tractors are useful for heavy pushing or pulling operations requiring maximum power at relatively slow rates of speed. They are very suitable for excavating on a sidehill, and are preferred to the wheel-type tractor for this work. They are also used in quarry operations. A crawler-type tractor is shown in figure 3-1; this is an International Harvester, model TD-20B.

Wheel-Type Tractors

Wheel-type tractors, as the name suggests, are tractors mounted on wheels. They are four-wheeled, pneumatic-tired vehicles, designed primarily for use as prime movers, for light dozing, winching, and towing. A wheel-type tractor which you will likely see in use by the SEABEES is illustrated in figure 3-2. They are often referred to as rubber-tired tractors. Rubber-tired tractors



29.62
Figure 3-1.—Crawler tractor.

29.61
Figure 3-2.—Rubber-tired tractor.

are frequently used where the haul distance is long enough to develop high average haul and return speeds, or where crawler-type tractors would be likely to damage road or runway surfaces. They operate well on loam, gravel, smooth rock, or paved surfaces. They are used by the Navy, where the going is easy, to speed up work and provide greater compaction, since wheels compact better than crawler tracks. These tractors may pull scrapers, plows, drags, and road graders, various types of rollers, water wagons, and so on. You may see a rubber-tired tractor fitted with a front-end loader; this attachment is useful for moving dirt from roads and sidewalks.

Tractor Attachments

Attachments make the tractor a versatile machine. Among attachments frequently used are bulldozer and angledozer blades, towed scrapers, and front-end loaders.

A tractor on which a bulldozer or angledozer blade has been mounted is commonly known as a DOZER. Some of the operations performed by dozers include spreading material, removing trees and brush, and digging ditches.

Bulldozer and angledozer blades can be mounted on either crawler-type or rubber-tired tractors. And, they may be operated either hydraulically or by cable. The tractor shown in figure 3-1 is equipped with a hydraulically controlled bulldozer blade. Bulldozer and angledozer blades are manufactured by various companies; types are available to fit any make and model of tractor.

The bulldozer blade can be used only at an angle of 90 degrees to the center axis of the tractor. Some bulldozers are equipped for TILTING the blade forward or backward. Tilting is helpful in extra hard soil, and also for rooting out boulders with one end of the blade.

An angledozer blade is one which can be angled approximately 30 degrees to either side from the 90-degree position.

The bulldozer is used mainly for straight drifting, but it can be used for sidecasting by making a series of pivoting passes. The angledozer is better suited for sidecasting because pivoting is usually unnecessary, thereby speeding up the work.

In earthwork, STRAIGHT DRIFTING means pushing earth straight ahead. SIDECASTING means pushing earth to the side in the manner of a plow.

A TOWED scraper is a four-wheeled rig which is towed by a prime mover. It can handle a variety of earthmoving operations, such as digging, loading, hauling, dumping, and spreading material. Scrapers are especially useful on large earthmoving projects such as airfield or road construction. Both crawler-type and rubber-tired tractors are used to tow scrapers.

Scrapers consist of a body or a bowl and frame that moves on large pneumatic tires. (See fig. 3-3.) The bowl can be raised or lowered in the frame by either a cable and drum arrangement or by hydraulic cylinders and pistons. It is loaded by being pulled and often assisted by being pushed across the earth being excavated. When the bowl is filled, it is raised and

115.148
Figure 3-3.—A towed scraper.

carried to the place desired. The earth is ejected by moving the tailgate forward in the bowl. Generally, a towed scraper (fig. 3-3) has a specially designed yoke that allows the front wheels to be removed. With the front wheels removed the scraper can be used with a two-wheeled prime mover.

Front-end loaders are attached to the front end of either a wheeled- or track-type tractor. The older type of front-end loader consists of a bucket (generally called a roll-back bucket) attached to a frame, which moves up and down and is tripped hydraulically to dump the load. It is used for loading trucks and trailers with sand, gravel, or dirt. It can be used also as an elevator for loading and unloading cargoes; that is why a set of forks is usually shipped with it for palletized cargo.

The new type of front-end loader, shown in figure 3-4, is equipped with a four-in-one bucket. It is so called because this type of attachment can perform four major functions. In accordance with the indicator setting, this loader can be used as a CLAMSHELL, BUCKET (for loading dirt, sand, gravel, etc.), SCRAPER or DOZER. This is the type most commonly used by the SEABEES.

29.64
Figure 3-4.—Front-end loader.

POWER CRANES AND ATTACHMENTS

The crane BASIC UNIT consists of a travel base, rotating base, engine, controls, winch drums, and operator's cab. The travel base consists of a crawler or wheel base on which the unit travels. The rotating base is a flatbed on which the engine, controls, drums, and cab are mounted. The attachments are fitted to the rotating base.

Cranes are widely used in construction work. A crane is a piece of equipment that can be used to handle various types and shapes of materials by changing the attachment at the end of the hoist lines. Many different attachments may be used with the basic machine. Four basic attachments are commonly used: (1) boom with hook-block, clamshell, or dragline; (2) shovel, (3) backhoe, and (4) piledriver.

When the crane is rigged with a hook-block attachment, it is used as a lifting crane. When equipped with a clamshell, dragline, shovel, or backhoe, the crane is used as an excavator.

There are three basic types of booms used on a crane. The CRANE-TYPE BOOM is used with the hook-block, clamshell, and dragline. The BACKHOE BOOM is used only with the backhoe attachment. The SHOVEL BOOM is used only with the shovel attachment.

Hook-Block Attachment

A crane rigged with a hook-block attachment is shown in figure 3-5. This rig, often called a lifting crane, is frequently used with slings for lifting and moving objects.

The lifting crane can be used in operations where the load must be placed well above ground level, as in erecting steel or stacking lumber. It can also be used in operations where loads must be placed at ground level; for instance, unloading railroad cars and storing materials. In addition, the crane can be used to place or lower loads well below the ground level; examples of this type of operation include laying pipe, and lowering and raising concrete buckets.

29.65
Figure 3-5.—Crane rigged with a hook-block attachment.

Clamshell Attachment

The CLAMSHELL attachment gets its name from its bucket. (See fig. 3-6.) With this attachment, the crane can be used for moving loose material, excavating, dredging, and other work where material is soft to medium hard and the clamshell teeth can dig.

The clamshell gives good results when used in confined excavations with vertical walls; for instance, foundations, footings, trenches (especially those which are cased in), and basements. It also works well for handling bulk materials. You may often see it used to load or unload railroad cars and other haul units, to build stockpiles of materials, or to charge bins and hoppers.

Dragline Attachment

The DRAGLINE attachment is named for its bucket and dragging action. (See fig. 3-7.) It can be used to excavate soft to medium hard material at, or below, ground level. It will excavate very wet material and is suitable for digging over a wide area. The dragline is suited to ditching and other excavation jobs where the work cannot be reached by other machines. This rig may also be used to load excavated materials onto a barge or into a truck. Dragline buckets are available in light, medium, and heavy weights. The dragline bucket can be cast out and dragged back with a load of dirt in places unable to support a tractor.

Power Shovel Attachment

When the crane basic machine is rigged with a POWER SHOVEL attachment, you have an excellent rig for excavating soft to very difficult material at, or above, ground level. It can also excavate slightly below ground level, but was not designed for this work. The shovel attachment is easy to recognize because it has a dipper-type device that works like a spade or hand shovel. (See fig. 3-8.) The shovel is commonly used in rock, gravel, and borrow pits. It is also used for loading or dumping material into rock crushing and screening plants.

Backhoe Attachment

The BACKHOE attachment is so named because of the resemblance of its working motion to that of the common garden hoe. (See fig. 3-9.) This is a useful piece of equipment for excavating soft to very difficult material at, or below, ground level. It is especially suited for digging wide trenches.

29.66
Figure 3-6.—Crane rigged with a clamshell attachment.

Piledriver Attachment

The PILEDRIVER attachment is just a lead to guide the pile to the desired angle while it is being driven. The hammer is also attached to this lead; although the power for lifting the hammer may come from another source. A crane rigged with a piledriver attachment is shown in figure 3-10.

A piledriver attachment equipped with a double-acting hammer may be used (when the hammer is in an inverted position) to pull piles. The hammer is turned over and a wire rope sling is passed over it and attached to the pile. The hammer whip is heaved taut, and the upward blows of the hammer ram on the sling, plus the pull of the hammer whip, are usually enough to pull the pile.

MOTORIZED SCRAPERS

In addition to towed scrapers, which were described earlier in this discussion, MOTORIZED SCRAPERS also are frequently used in earthwork operations. The motorized scraper is a two-wheeled rig with an attached rubber-tired prime mover, as shown in figure 3-11. Some motorized scrapers are equipped with two-wheeled prime movers. (See fig. 3-12.)

As you might guess, motorized scrapers are operated in the same or similar manner as towed scrapers except for the pulling unit.

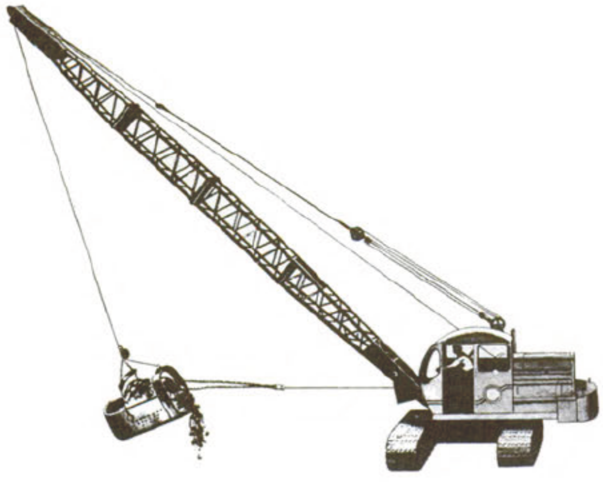


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Figure 3-7.—Crane rigged with a dragline attachment.

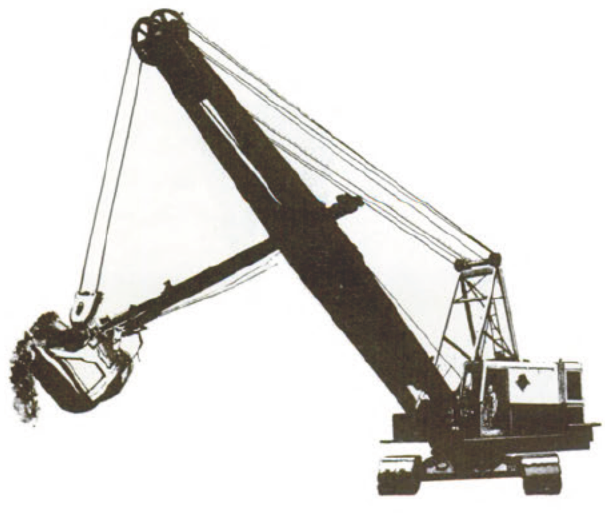

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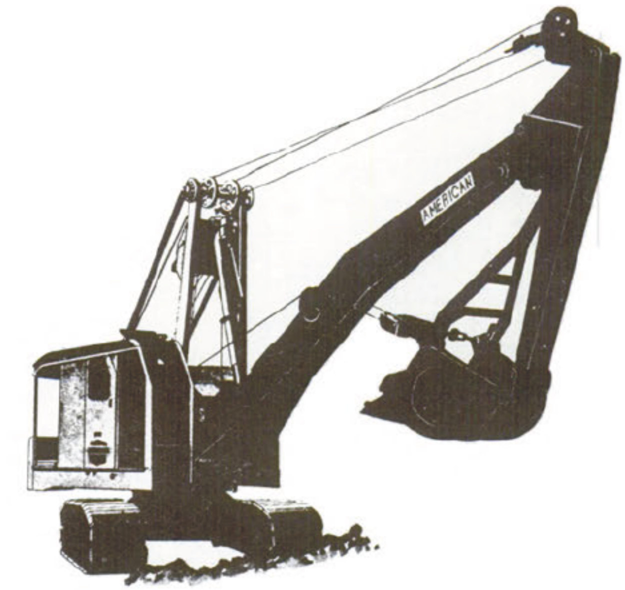
Figure 3-8.—Crane rigged with a shovel attachment.



29.69
Figure 3-9.—Crane rigged with a backhoe attachment.

Motorized scrapers—same as the towed scrapers—are capable of digging, loading, hauling, dumping, and spreading massive amounts of material. They are especially useful on large earthmoving jobs, such as airfield construction and road projects located in rolling terrain, necessitating many cuts and fills. They make shallow cuts while loading, transport large loads for considerable distances at relatively high speeds, and spread material in thin, uniform layers.

MOTOR GRADERS

The MOTOR GRADER is a machine which is used mainly for final shaping and finishing, rather than for digging and earthmoving. It is also used for blade-mixing of paving materials, for ditching, and for scarifying (breaking up dense material).

A motor grader has a long bridge-like frame which supports the engine and blade (fig. 3-13). It has two or more driving wheels and various steering- and blade-control mechanisms. The blade-control mechanisms may be either mechanically or hydraulically operated.

Graders are manufactured with either diesel or gasoline engines, and in a variety of models by a number of manufacturers.

DITCHERS

A DITCHER is a mechanical excavator which is used to dig trenches for water pipes, sewer pipes, fuel pipes, electric cables, and the like. A ditcher may be either crawler-mounted or wheel-mounted. There are two main types of

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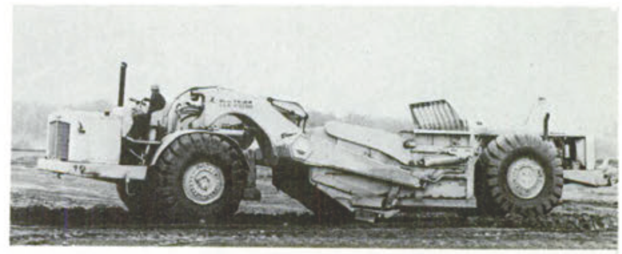
Figure 3-10.—Crane rigged with a piledriver attachment.

29.63
Figure 3-11.—Motorized scraper.



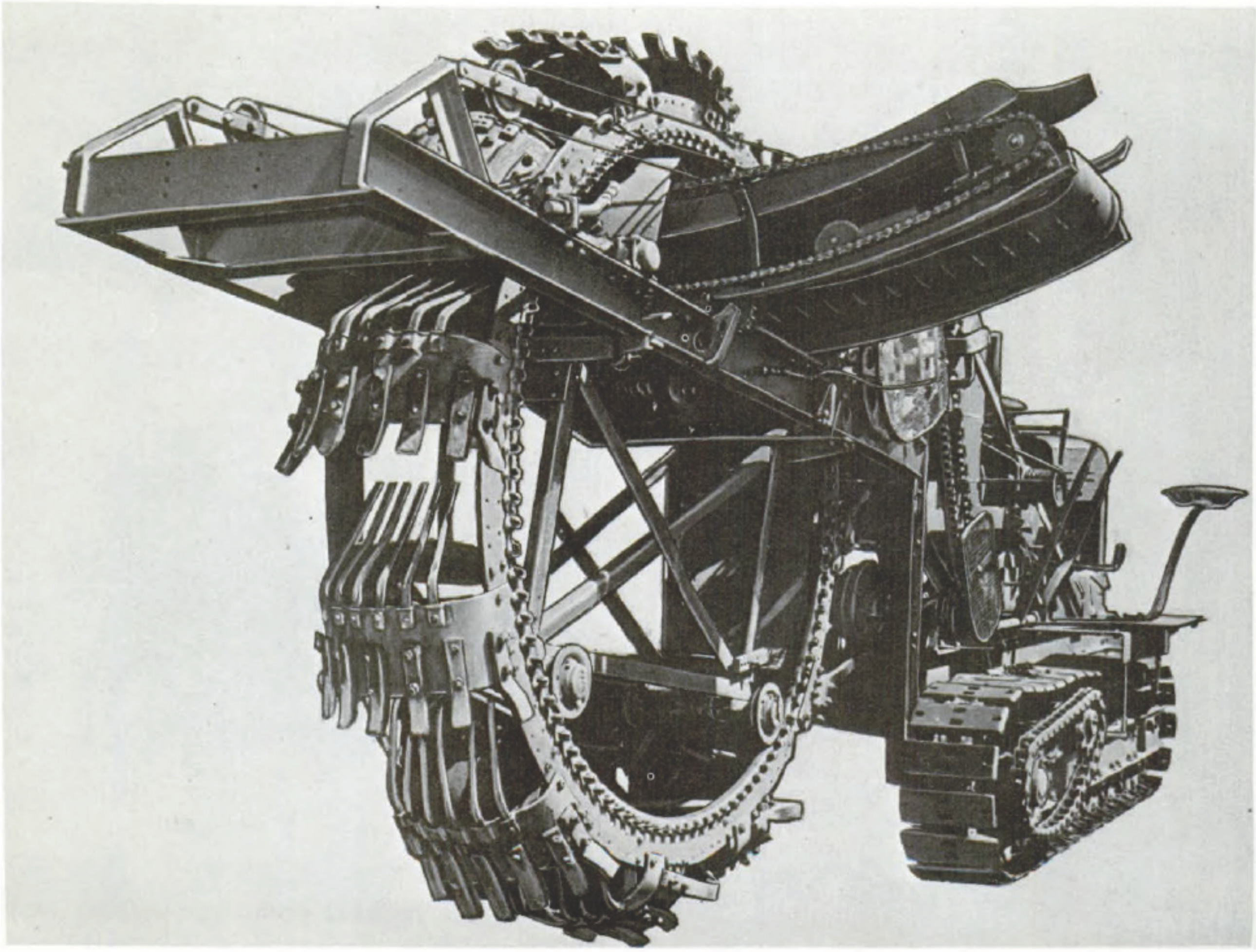
115.205
Figure 3-12.—Two-wheeled self-propelled scraper.

29.71
Figure 3-13.—Motor grader.

ditchers: the vertical boom type and the wheel type.

The VERTICAL BOOM ditcher is equipped with a number of digging buckets. The buckets are mounted on an endless chain which travels around a long steel boom. The boom sets vertically when in operation. It can be raised and lowered to control the depth of the cut, and also to "jump" such obstacles as buried pipes, rocks, and electric cables. As each loaded bucket rides over the top of the boom, it dumps its load on a belt-type SPOIL CONVEYOR, which carries the excavated material to one side or the other and deposits it in a windrow as the rig proceeds along the line of the trench.

On a WHEEL ditcher (fig. 3-14) the digging buckets are mounted on a large wheel, which is in turn mounted on a frame-type horizontal boom that can be raised or lowered. Like the vertical boom ditcher, the wheel ditcher is equipped with a spoil conveyor for carrying the excavated material out to one side.



115.166
Figure 3-14.—Wheel ditcher.

COMPACTION EQUIPMENT

Various types of ROAD ROLLERS are used for final surface compaction of roads, airport runways, and other surfaces. Both motorized and towed types of rollers are available.

Motorized Rollers

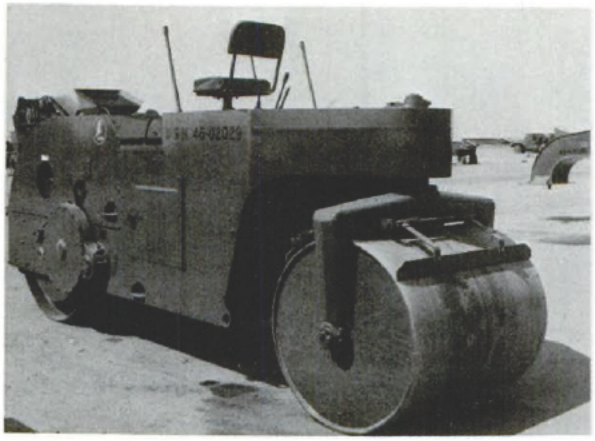
Two common types of MOTORIZED roller used by the Navy are the tandem roller (fig. 3-15) and the three-wheeled roller (fig. 3-16). The tandem roller is used for smooth finishing work on crushed stone, coral, asphalt, or like material. The three-wheeled roller is used for rough finishing and is less likely to be tipped over by rough going than a tandem roller.

Motorized rollers are designated according to weight, and they range in size from 3 to 50 tons. Tandem rollers, with cylinders instead of spoked wheels, are designed so that the cylinders may be filled with water for additional weight. The power plant used in motorized rollers is, as a rule, a gasoline engine. However, some rollers are powered by diesel engines.

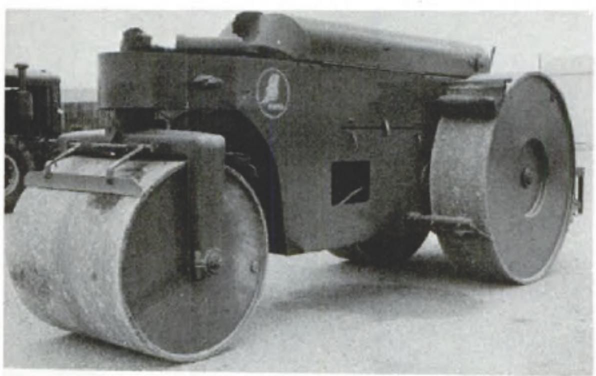
Towed-Type Rollers

There are three types of TOWED rollers used by the Navy. They are (1) tamping or sheepsfoot roller, (2) grid roller, and (3) rubber-tired roller.

The SHEEPSFOOT roller, shown in figure 3-17, compacts or tamps the material being



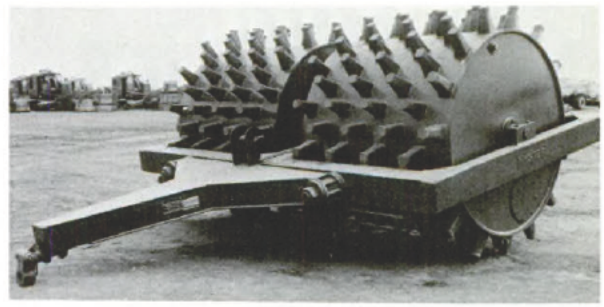
29.73.2
Figure 3-15.—Tandem road roller.



29.73.3
Figure 3-16.—Three-wheeled road roller.

rolled. As you can see, the sheepsfoot roller is a round drum, fitted with tampers or "feet." The marks made by the roller look like those left by a herd of sheep; it is from these marks that the roller gets its name.

The sheepsfoot roller may be towed by a crawler or wheel-type tractor. The rollers may be joined together side-by-side, hitched one, two, or three behind one another, or rigged in various ways to tamp the most ground in the least amount of time. These rollers are made in various sizes and weights, from 1 1/2 tons to 9 tons. Most of them can be filled with water for additional weight.



29.74
Figure 3-17.—Sheepsfoot roller.

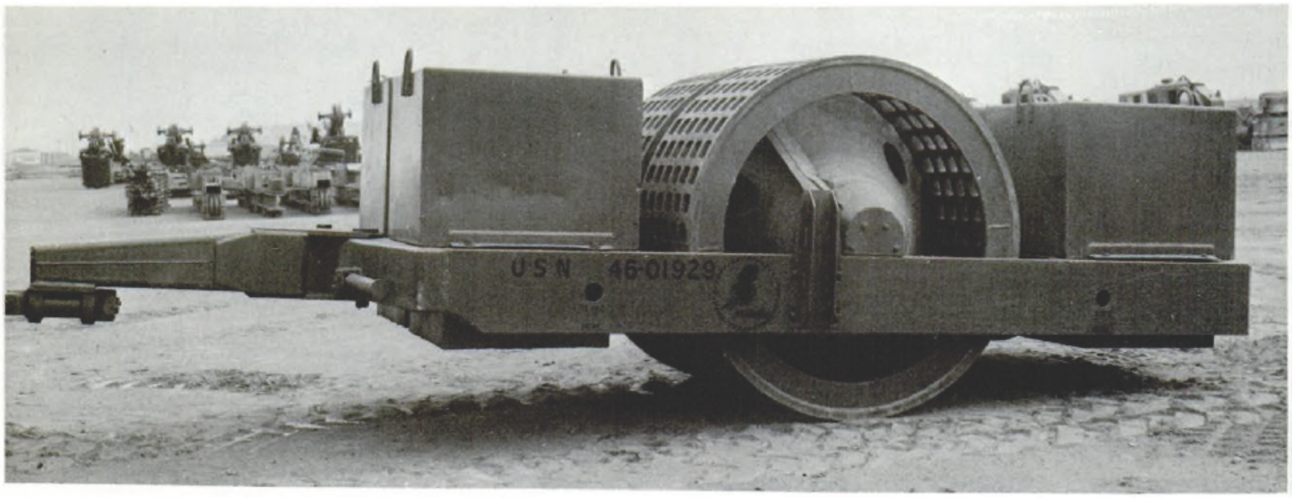
The GRID roller, shown in figure 3-18, is used to break up old bituminous road surfaces, to compact highway base courses, and to crush such materials as sandstone, soft limestone, and cinders. Its housing or frame is very similar to the sheepsfoot roller except for the roller part. The grid roller is usually ballasted with dirt, sand, or large blocks of concrete to attain more weight.

The RUBBER-TIRED roller is shown in figure 3-19. This roller is commonly called a WOBBLY roller, because the rubber-tired wheels wobble when the roller is in motion. The wobble is intentional, since the individual axles on which the wheels turn are not parallel to each other. When towed, the wheels have a kneading action on the surface being rolled. The body of the roller is built to carry additional weight, which may be sand or other suitable material.

AIR COMPRESSORS

Most air compressors used by the SEABEES are mounted on trucks, trailers, skids, or wheel mountings. They come in different types and sizes and each type may use a different fuel or source of power. Their air pressure output is governed by a control device which is preset to a certain pressure, usually between 90 psi (pounds per square inch) and 100 psi.

The air compressor provides a constant supply of air at sufficient pressure to operate the assortment of pneumatic tools powered by the unit. It is from this unit that the rock drill, for example, obtains power necessary to cut its way through solid rock. On construction sites it is not unusual to see several different tools being operated by power from the same compressor and at the same time.



81.312
Figure 3-18.—Grid roller.

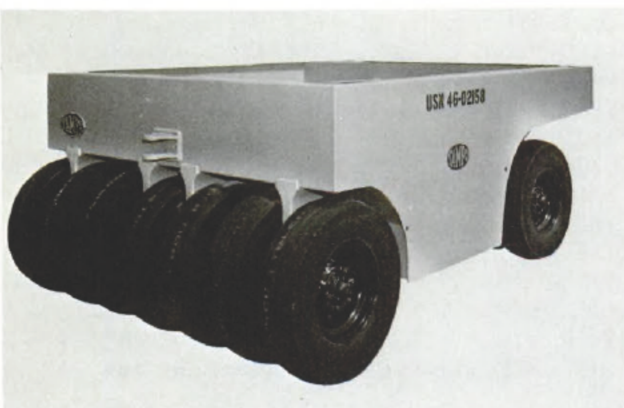


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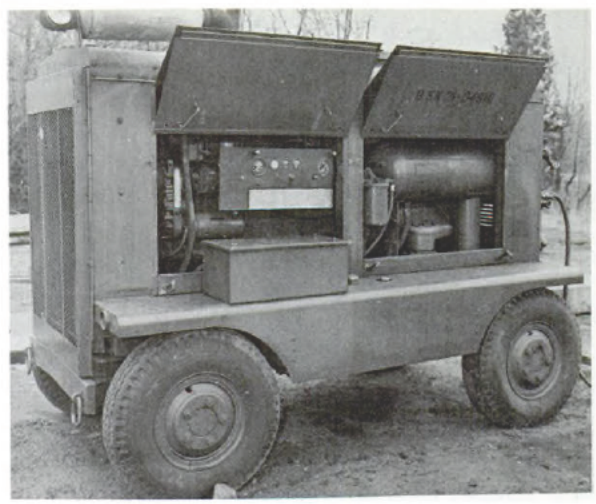
Figure 3-19.—Rubber-tired roller, towed type.



29.216
Figure 3-20.—Air compressor.

Portable compressors are gasoline-engine driven, diesel-engine driven, or electric-motor driven. In the Navy, diesel-engine driven compressors are used a great deal. Figure 3-20 shows you a portable diesel-engine driven compressor designed for heavy-duty work.

ROCK CRUSHERS

Rock crushers and related types of equipment take large pieces of rock or other materials and reduce them to sizes suitable for use as aggregate in the construction of roads, airfields, and other construction work. The aggregate is crushed, screened, graded, and washed, as necessary, to process it properly. Various types of equipment can be used to produce the desired kinds of aggregate. Crushing equipment generally is located near the quarry face—but far enough away to prevent it from being damaged by blasting or falling rocks.

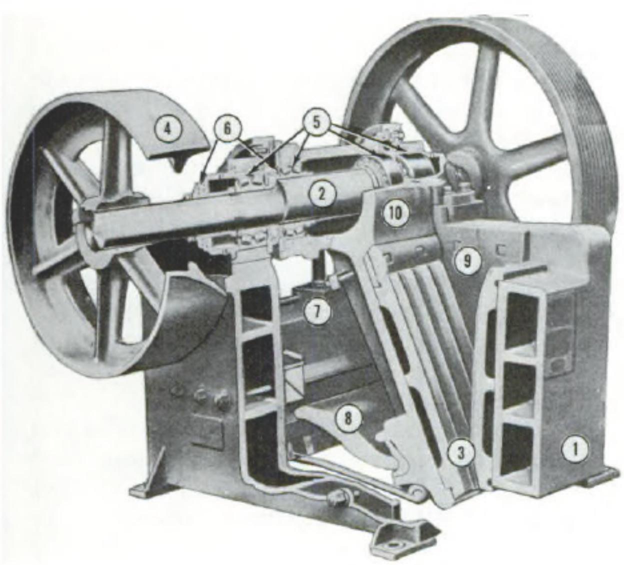
There are several common types of ROCK CRUSHERS. Most portable crushing equipment

of the type used by the Navy is equipped with jaw, or with jaw and roller, crushers. A cutaway view of a typical jaw crusher is shown in figure 3-21.

Jaw crushers are used mostly for the PRIMARY crushing of large rocks. Roller crushers are used mostly for the SECONDARY crushing of rocks which have been partially reduced by primary crushing.

Crushing and Screening Plants

At some activities, you will see a CRUSHING AND SCREENING plant. This is a complete plant for reducing stone to a given maximum size. Figure 3-22 shows a schematic drawing of a simple type of crushing and screening plant. The material is fed into a FEED HOPPER, which is covered by a SCALPING SCREEN which rejects rocks that are too large to enter the jaws of the crusher. A very coarse scalping screen, usually made up of heavy bars, is called a TRAP GRATE or GRIZZLY.



1. Welded Steel Base
2. Overhead Eccentric shaft
3. Crusher Jaws
4. Flywheels
5. Bearings
6. Oil Seals
7. Adjusting Mechanism
8. Toggle Plate
9. Cheek Plates
10. Pitman

29.90
Figure 3-21.—Typical jaw crusher.

From the bottom opening of the feed hopper the material feeds onto a belt FEED CONVEYOR, which carries it up to the top of a DELIVERY HOPPER. The delivery hopper is covered by a VIBRATING SCREEN, through which material too small to require crushing passes into the delivery hopper. The vibrating screen deflects material which is large enough to require crushing into the jaws of the crusher. Materials passing through the jaws of the crusher, and also materials passing through the bottom opening of the delivery hopper, are picked up by a belt DELIVERY CONVEYOR, which deposits the material in a pile or in trucks, as desired.

Safety Precautions

The chief dangers around crushers include the danger of falling, the danger of being struck by rock falling from above, and the danger of being caught in moving machinery. In case you should be working around crushers, closely observe the following precautions:

NEVER ride on a conveyor belt.

NEVER cross a conveyor belt or bucket conveyor, except at regular designated and properly guarded crossings.

NEVER work under overhanging loose material.

ALWAYS wear a hard hat.

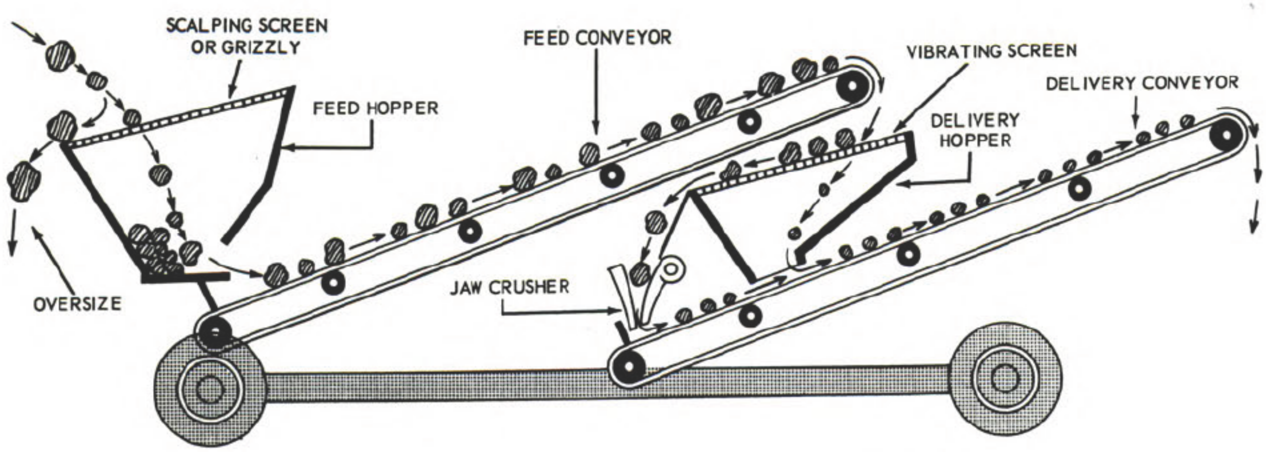
ALWAYS wear goggles around an operating crusher.

ALWAYS wear dust respirators, when required, while working around crushers.

EARTHWORK EQUIPMENT SAFETY

As with transportation equipment, SAFETY precautions must be observed at all times when working around earthwork equipment. Although Constructionmen operate earthwork equipment only under supervision or after receiving special instruction, they often work around such equipment. Being alert to danger and taking proper action in an emergency are important safety factors for anyone working around earthwork equipment. A few safety precautions of concern to the CN follow.

In all phases of earthwork, remember to stand a safe distance from machines or equipment which are in operation; also keep a safe distance from moving logs and taut lines.



29.91
Figure 3-22.—Crushing and screening plant.

Never ride on the drawbar of a tractor. Many serious accidents have resulted from this dangerous practice.

Wear personal protective equipment or clothing of approved type for protection against bodily injury, while working in water, swampy areas, on ice, and under other hazardous conditions.

Do not work or walk under crane booms, suspended loads, or buckets; serious, sometimes fatal, accidents are caused by this practice. Always wear a hard hat when working near cranes, scaffolds, and other places from which an object can fall.

On projects where a crane is used for hoisting and moving heavy loads, a signalman may be assigned to give directions to the crane operator by means of hand signals. (See fig. 3-23.) Generally speaking, a crane operator should accept signals only from the person designated as signalman. An exception to this rule is the EMERGENCY STOP signal (view R, fig. 3-23); all persons working around a crane should know this signal. The operator should obey the emergency stop signal when he receives it from any person.

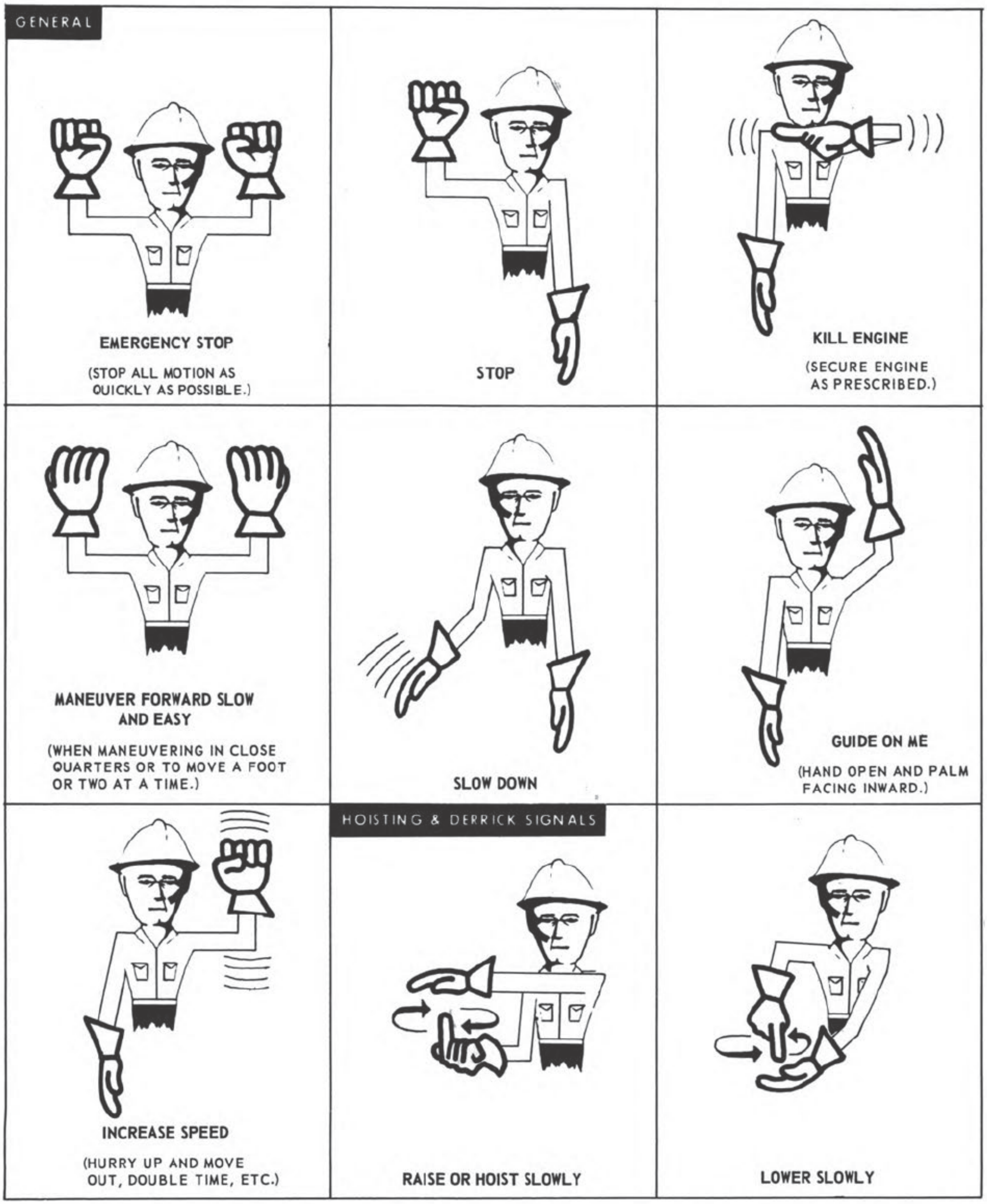
In clearing and excavating operations, explosives are sometimes used to remove stumps, rock, and other firmly embedded material. Safety measures in connection with blasting are described in chapter 6 of this training manual.

ASPHALT MIXING PLANT

One of the major jobs assigned to the SEABEES is the paving of surfaces such as highways, airfields, hardstands, and open storage spaces. A great quantity of paving material is generally required for these projects. The paving material may be either concrete or asphalt. Because asphalt is cheaper than cement and easier to place, it is frequently used—especially in advanced base construction. Consequently, this necessitates the operation of an ASPHALT MIXING PLANT. The plant is necessary for mixing the asphalt with the aggregates properly and efficiently; furthermore, a well-proportioned mix is maintained because of properly controlled measuring devices, and temperature of the mix is maintained at a desired level, thereby obtaining best results.

From the discussion on rock crushers you will recall that rocks such as limestone and granite, which have been crushed and screened, are used as AGGREGATES. Other common types of aggregates are sand, gravel, slag, and so on. The aggregate frequently used with asphalt for paving purposes ranges in size from a very fine, almost powdery FILLER, through sand and gravel to particles as large as 3 inches in diameter. The asphalt is the binder, which is generally referred to as a BITUMINOUS MATERIAL and BINDER. The resulting pavement is referred to as a BITUMINOUS SURFACE.

The operation of an asphalt plant is one of the primary duties of Equipment Operators. However, they are usually supported by a few



29.86
Figure 3-23.—Construction hand signals.

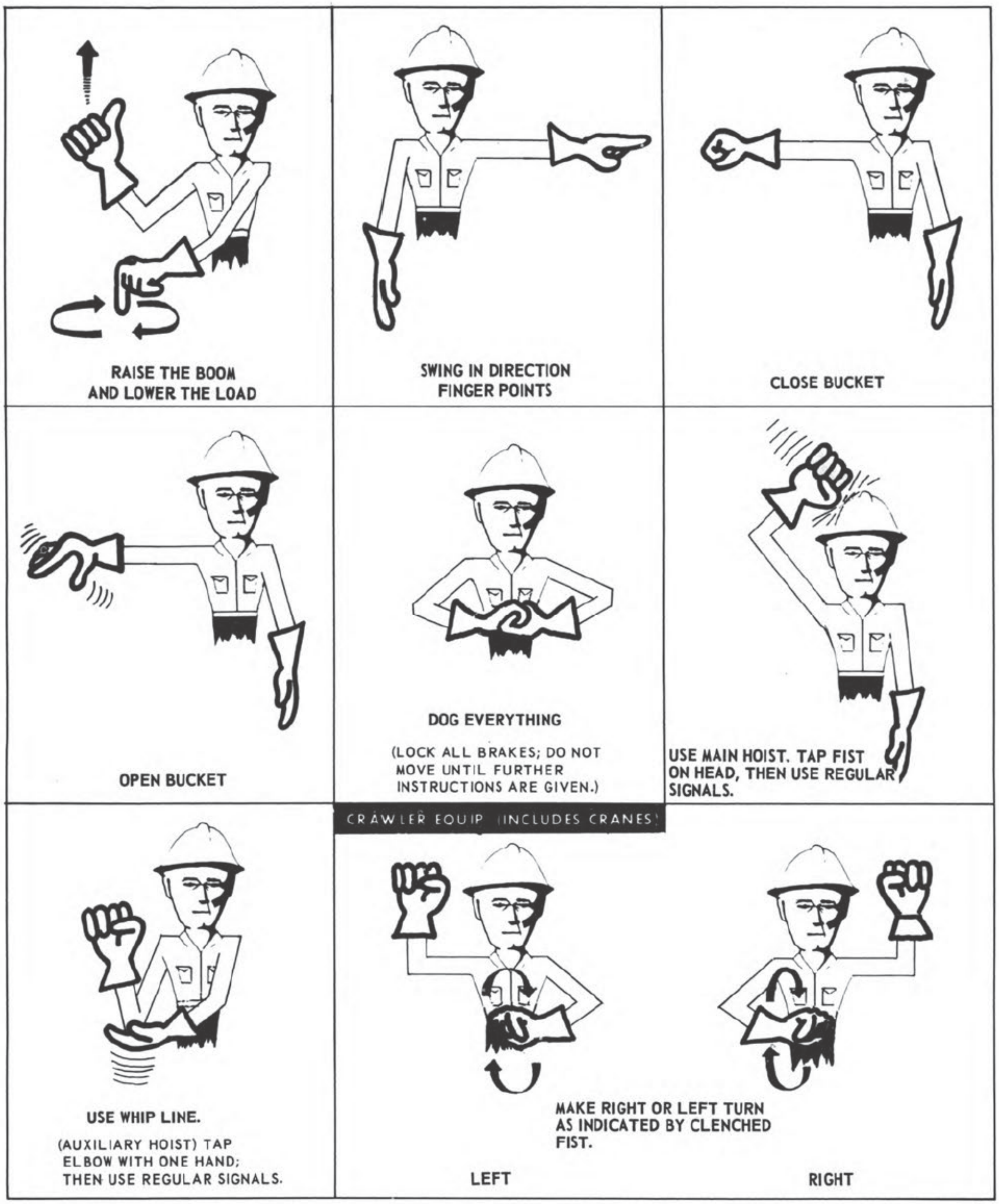


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Figure 3-23. — Construction hand signals — continued.

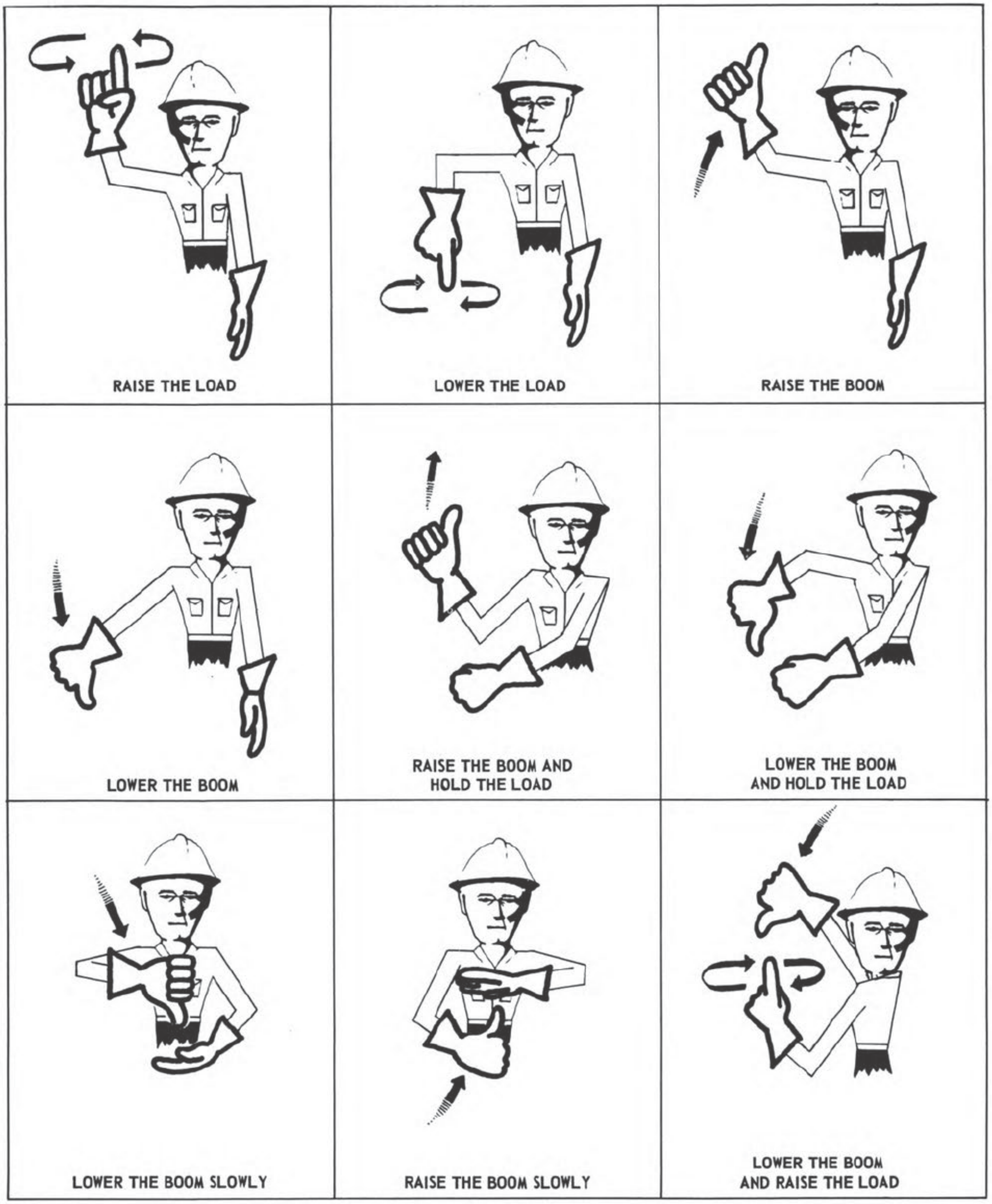

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Figure 3-23.—Construction hand signals—Continued.

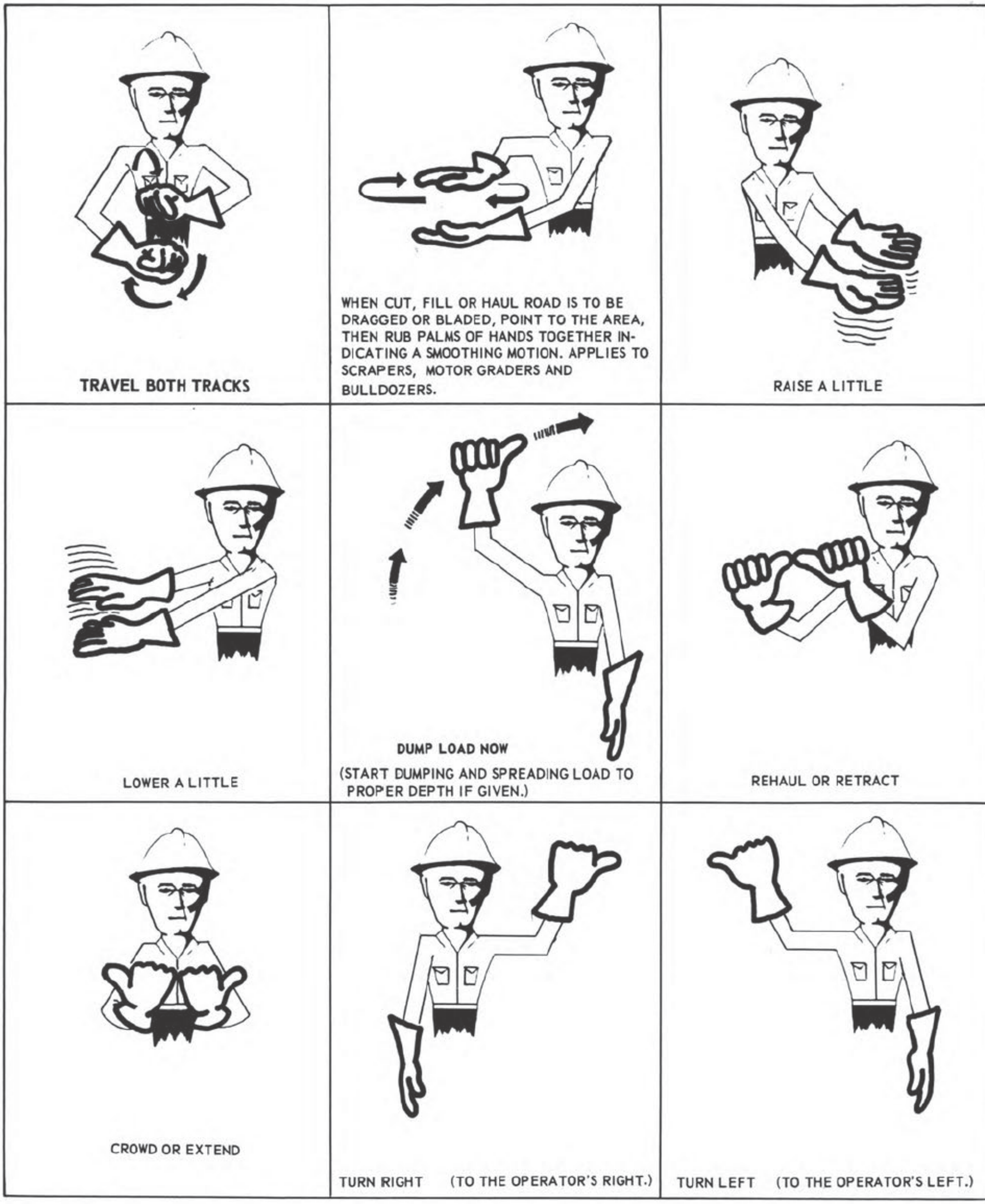

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Figure 3-23.—Construction hand signals—continued.

Construction Mechanics and Construction Electricians who maintain and/or operate support equipment. The CMs maintain support equipment such as dump trucks, fork lifts, front-end loaders, and so forth; the CEs operate and maintain the generator plant if base power is not available, or, if available, they take care of any electrical trouble that may arise in the plant.

As a Constructionman, you may be detailed to work in an asphalt plant. You will perform various duties that may be given you by petty officers in charge of the plant. Your duties around the asphalt mixing plant may consist of the following: helping set up the plant, if necessary; adjusting various controls upon orders from the leading petty officer; lubricating the equipment as required; keeping an adequate supply of asphalt available for continuous flow; removing aggregate that falls from the bins and elevators; and general policing of the area around the plant.

Depending upon the construction site, the bituminous material may be delivered to the plant by several methods. The asphalt may be carried in by rail or truck tanks, or it may be trucked or railed to the site in 55-gallon drums.

Asphalt that arrives at the site in a fluid state presents no problem. Solid or semisolid asphalt, however, is another matter; it is necessary to provide some means of heating the drums to bring the binder to flow from the drums into heated storage tanks. In some cases, the drums are ripped open with axes and the asphalt is extricated from the drums before being dumped to the asphalt heater tanks.

The plant generally operates around-the-clock to maintain the proper temperature of the mix and to ensure an adequate supply of the mixed bituminous materials. Once a job is started, three 8-hour shifts are worked until the job is completed. Whatever task is given you, always pay undivided attention to your work, and observe all the safety rules in effect around the plant.

TYPES OF ASPHALT MIXING PLANT

In a sense, the choice of what type of asphalt plant to employ depends upon the extent of the project and the most expedient method to be used in mixing the bituminous materials. If the project is large and requires work of high quality and speed, a large and more sophisticated plant is employed; a mix plant with the minimum of component parts is used on a small or ordinary paving project.

The mixing process is broadly divided into ROAD MIXING and CENTRAL PLANT MIXING. Road mixing, as the name implies, is a method in which the aggregate and binder are mixed on the road. In central plant mixing, the aggregate and binder are mixed at some centralized location away from the road site—frequently at the aggregate source—and the mix is then transported to the site by appropriate conveyance.

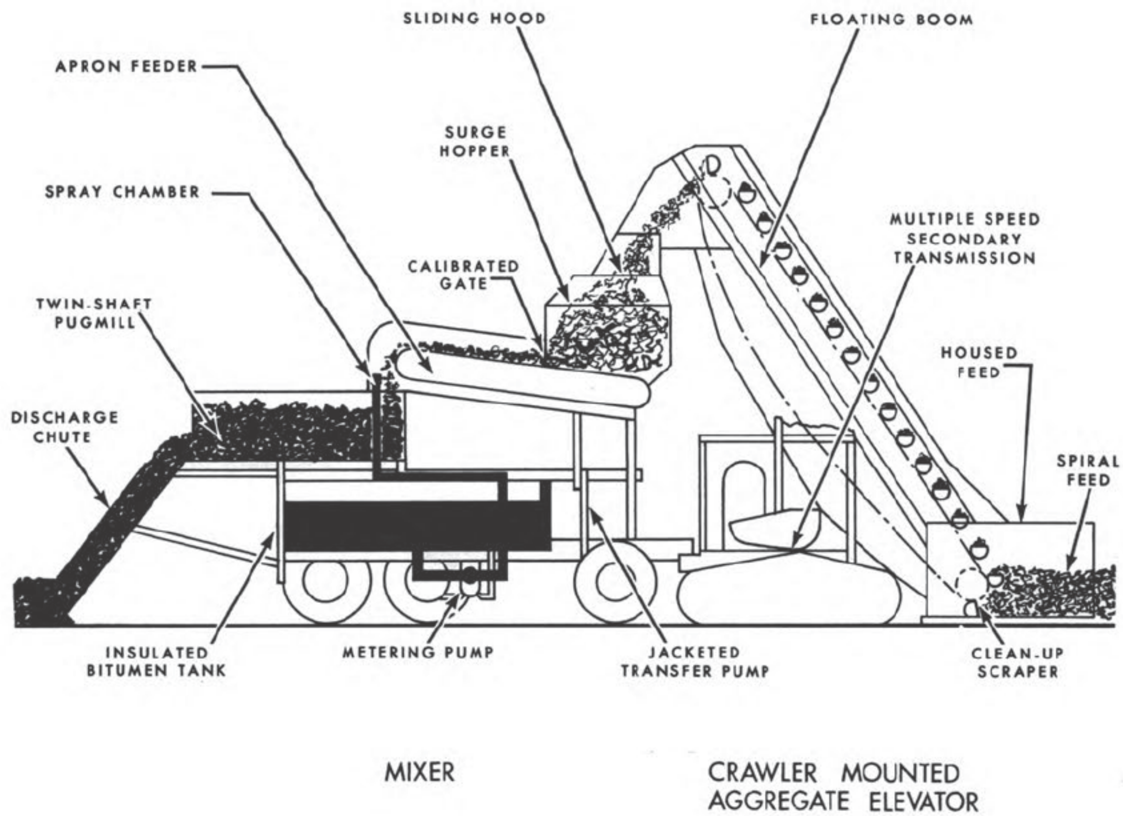
In road mixing, the aggregate is laid out along the road in a windrow (row), the bituminous binder is added, and the two are then mixed together. Incidentally, the windrowed aggregate must usually be dried before the binder is added. This may be done by agitation with a blade, a harrow, or some similar device which exposes individual particles to the sun and air. There are three common methods of road mixing: blade, mechanical, and travel plant mixing.

In BLADE MIXING the binder is first sprayed on the windrowed aggregate, after which a motor grader does the mixing by blading the windrow back and forth across the roadway.

In MECHANICAL MIXING, a mechanical mixer moves along the windrow, picking up the material, mixing it with the binder in a mixing chamber called a PUGMILL, and then dropping the mix behind in a windrow. Not all mixers function the same. For instance, one type adds the binder at the time of mixing by spraying it into the pugmill as the mixer moves along the windrow.

In blade and mechanical mixing the proportion of aggregate to binder is difficult to control accurately. But, a TRAVEL PLANT accurately proportions the aggregate and binder, independently of the windrow size, travel speed, or human error. A schematic view of one type of travel plant is shown in figure 3-24. With this plant, the mix is discharged to a windrow at the rear of the travel plant.

There are two general types of central asphalt mixing plants: the BATCH MIX PLANT and the CONTINUOUS MIX PLANT. The chief distinction between the two is that in the batch mix plant, the aggregate is weighed out and the asphalt is measured out, a batch at a time by the operator, while the continuous mix plant provides a continuous flow by volume of automatically graded aggregate, mixed with a correct proportion of binder.



115.391
Figure 3-24.—Schematic view of a standard travel plant.

A schematic view of a complete asphalt batch mix plant is shown in figure 3-25; one type of continuous mix plant is shown in figure 3-26.

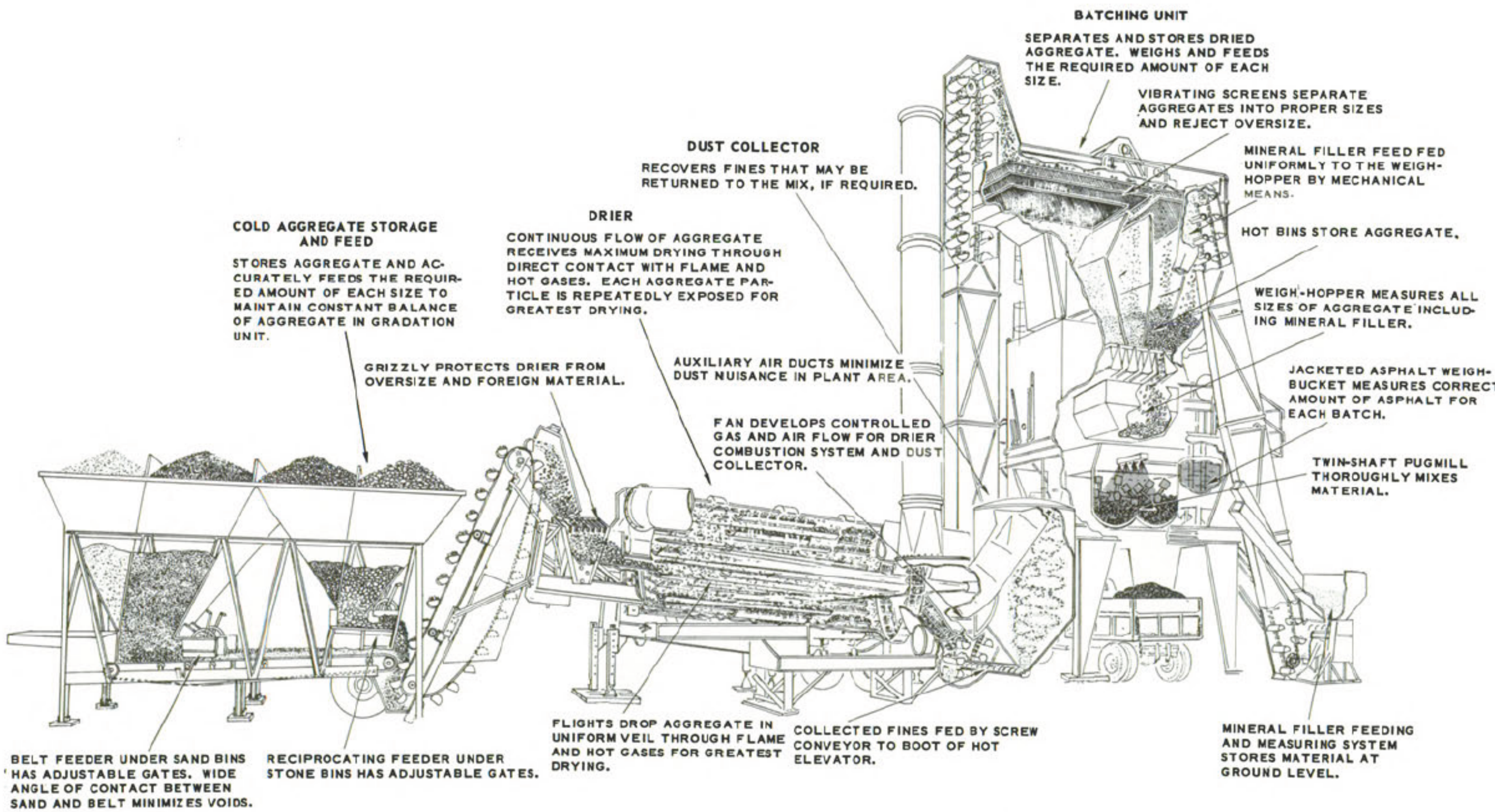
ASPHALT MIXING PLANT SAFETY

The need for adherence to safety regulations in any working condition must be continually emphasized. Navy regulations require that your supervising petty officer be responsible for your safety; however, he will not be watching you at all times. The best he can do is to eliminate hazardous situations in the job, warn you about existing hazards that are built-in the job, and require you to wear safety gear and clothing. You must remember that the actual observance of the safety rules is your responsibility. You can be put on report for deliberate violation of safety rules.

Some of the main hazards around the asphalt mixing plant are as follows:

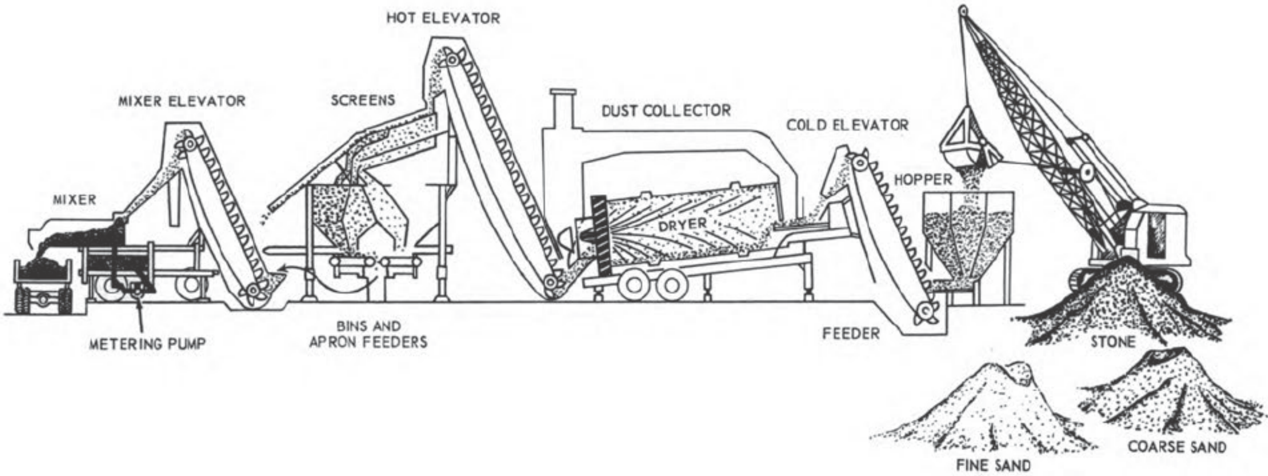
1. Burns from hot bituminous mix; hot bituminous material coming in contact with the skin will leave serious burns. Be sure to wear the proper clothing. Wear loose, heavy clothing (in good condition), closed at the neck, sleeves rolled down over the top of the gloves, and trousers extending well down over the top of the safety shoes. Goggles must be worn to prevent eye burn from splashing asphalt.

2. Moving equipment and falling objects; this includes the support equipment and the moving parts of the plant itself. Concentrate on your work and watch out for this equipment, especially when overhead crane attachments, such as buckets or clamshells, are used. Sometimes aggregates spill from the elevators and bins; be alert at all times. Wear a hard hat whenever you work around the plant.



143.66

Figure 3-25. Schematic view of a batch mix plant.



29.93

Figure 3-26.—Schematic view of a continuous flow asphalt plant.

3. Flash fire; controlled heat is used in heating kettles, mixers, and other equipment used to liquify asphalt. Open flames or sparks must NOT be permitted close to this material to avoid ignition. Know the location of the nearest fire extinguisher whenever you are in this situation. Presence of mind is very important in flash fires.

4. Fumes; avoid continuous exposure to the fumes of hot asphalt. Stay on the windward side whenever you have to work near such fumes.

Enumerated above are just a few of the various safety hazards that you may encounter around an asphalt mixing plant. Common sense, the use of proper judgment, and religious observance of the posted rules in the plant are generally the best protection against all hazards.

ASPHALT PAVING EQUIPMENT

ASPHALT PAVING EQUIPMENT includes all laydown and support equipment used in bituminous paving operations. This includes equipment such as ASPHALT FINISHER, ASPHALT DISTRIBUTOR, ASPHALT KETTLES, and the like.

ASPHALT FINISHER

The asphalt finisher, shown in operation in figure 3-27, is used to lay the hot bituminous mixtures produced by the plants. The finisher lays asphalt in widths varying from 8 to 12 feet; the variable width is made possible by the use of extension plates or cutoff shoes. The thickness of the lift can be varied from 1/4 inch to 6 inches in depth and the crown of the lift from a minus 1/2 inch to a positive 2 inches in the center of the lift. Material is fed from an 8-ton capacity hopper to the finishing part of the unit where it is distributed by spreading screws across the full width of the lift. The material is then struck off by the screeds and compacted by the tamping mechanism. The screeds are heated to prevent pickup of the material and the tamper provides approximately 85 percent of the desired compaction. The final tamping or finishing is accomplished by using tandem rollers.

ASPHALT DISTRIBUTOR

The asphalt distributor (fig. 3-28) is used to apply the tack coat and asphalt to bituminous surfaces. The application rate of the distributor is controlled by the length of the spray bar, the pump output, and the forward speed of the truck. The width of the sprayed area depends upon the length of the spray bar, which can be varied in 1-foot increments from 4 feet to 24 feet.

ASPHALT KETTLES

The most commonly used asphalt kettles are described in this section.

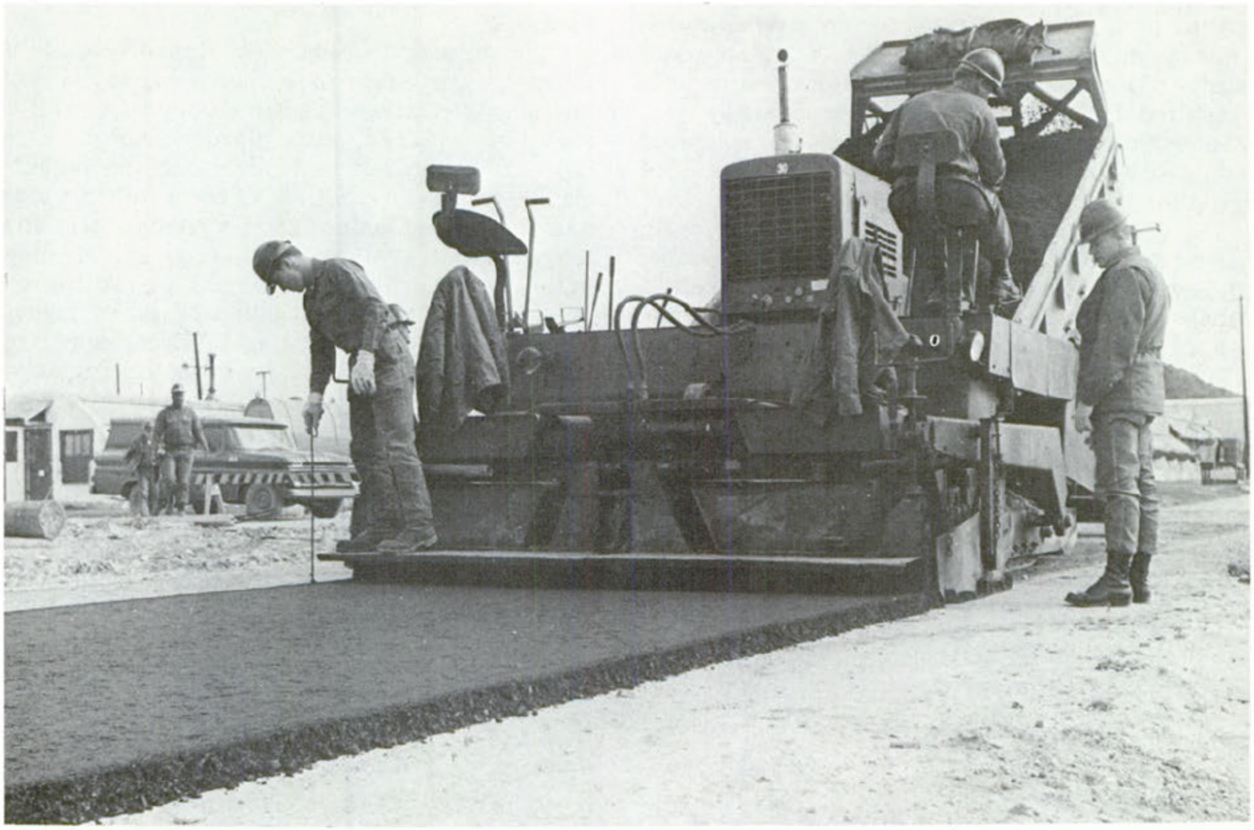


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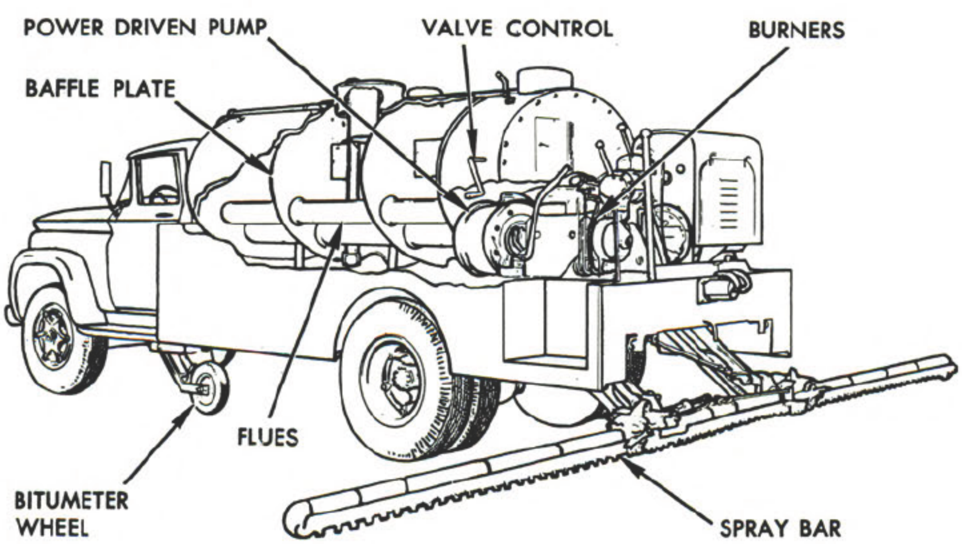
Figure 3-27. — Asphalt finisher in use by SEABEES.



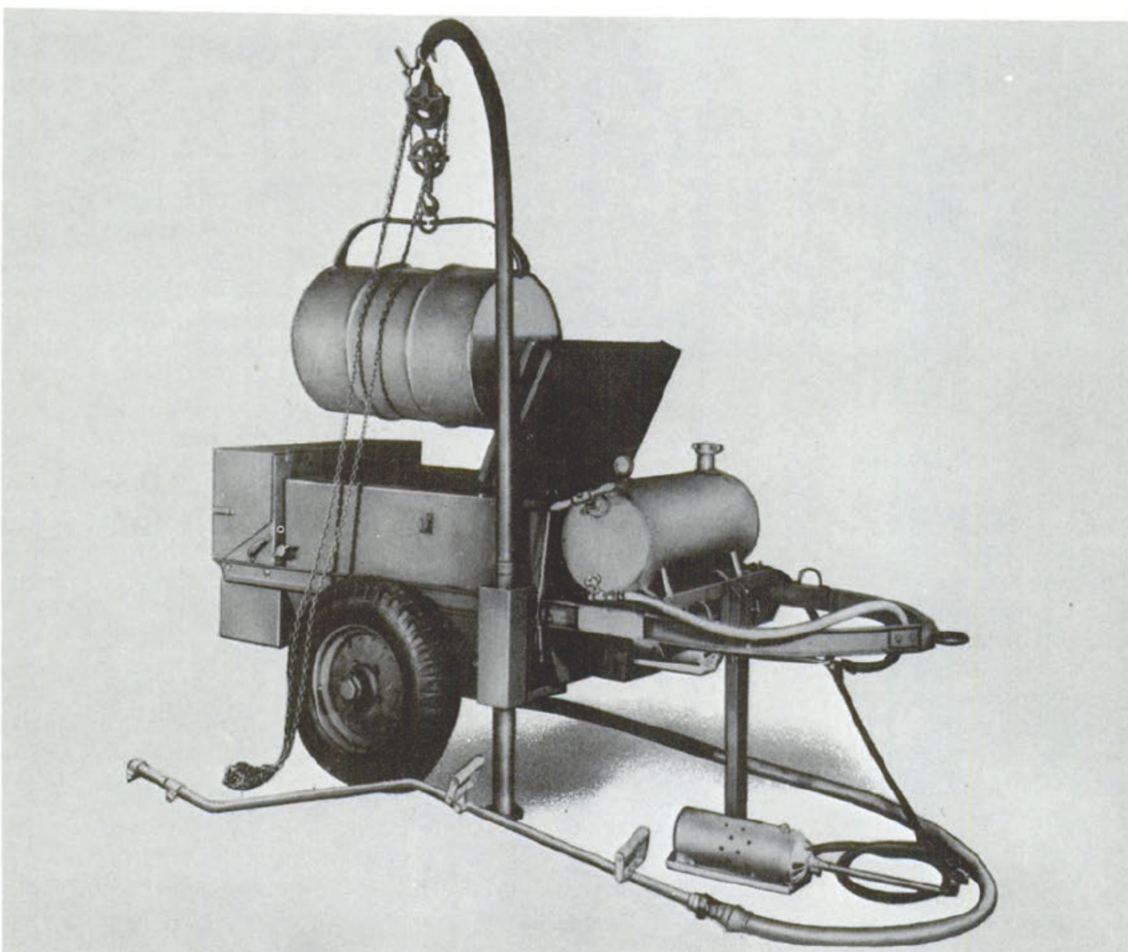
115.398
Figure 3-28. Asphalt distributor.

The 165-gallon kettle, shown in figure 3-29, is used primarily for repair-type paving work. It has a capacity of heating and melting approximately 100 gallons per hour. The melted asphalt is applied by means of a hand-type spray bar. To prevent damage to the kettle, the specified amount of asphaltic material must be maintained during the heating process.

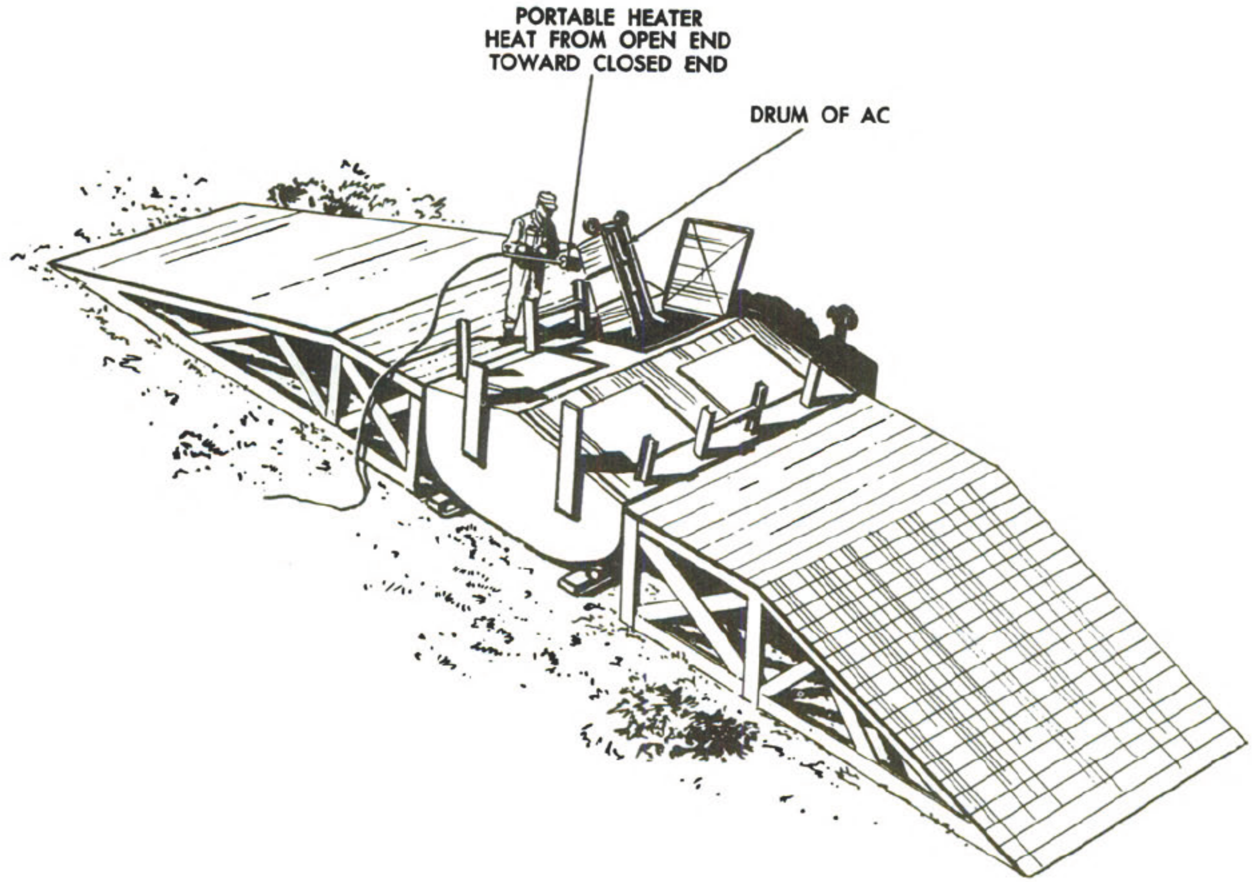
The 750-gallon asphalt kettle, figure 3-30, is used primarily for dedrumming and heating, and serves as a storage tank for the heated asphalt before distribution. It is normally kept at a stationary point. It can dedrum from 8 to 12 drums per hour, depending on the atmospheric temperature and the method used in loading the kettle. A pump may be attached for transferring the melted asphalt to distributor trucks.

AGGREGATE SPREADER

The aggregate spreader, figure 3-31, is used to apply aggregate to a freshly sprayed asphalt surface in surface treatment operations. It consists of a 2 1/2 cubic yard capacity charging hopper, an aggregate feed roller, an adjustable strike-off gate, traction tires, a towing tongue, and a travel axle. During setup, the towing tongue and travel axle are removed. The aggregate spreader then rides on the traction tires. It is connected to the dump truck by means of a two-point quick-coupling hitch. The aggregate spreader is capable of applying aggregate when being towed or pushed behind the charging hopper. In surface treatment operations, however, the aggregate spreader is pushed by the dump truck.



115.202
Figure 3-29.—165-gallon asphalt kettle.



115.169
Figure 3-30.—750-gallon asphalt kettle with portable heater.

This allows the aggregate spreader and the dump truck to ride on the freshly laid aggregate. As the aggregate spreader moves along the project, the rotation of the traction tires drives the aggregate feed roller through a series of shafts, chains, and gears. The application rate of the aggregate (usually in lbs/sq yd) is controlled by the adjustable gate setting. The width of application ranges from 4 to 8 feet in 1-foot increments. The reduction in width is accomplished by installing blocking plates inside the charging hopper. The blocking plates merely block off a segment of the gate opening.

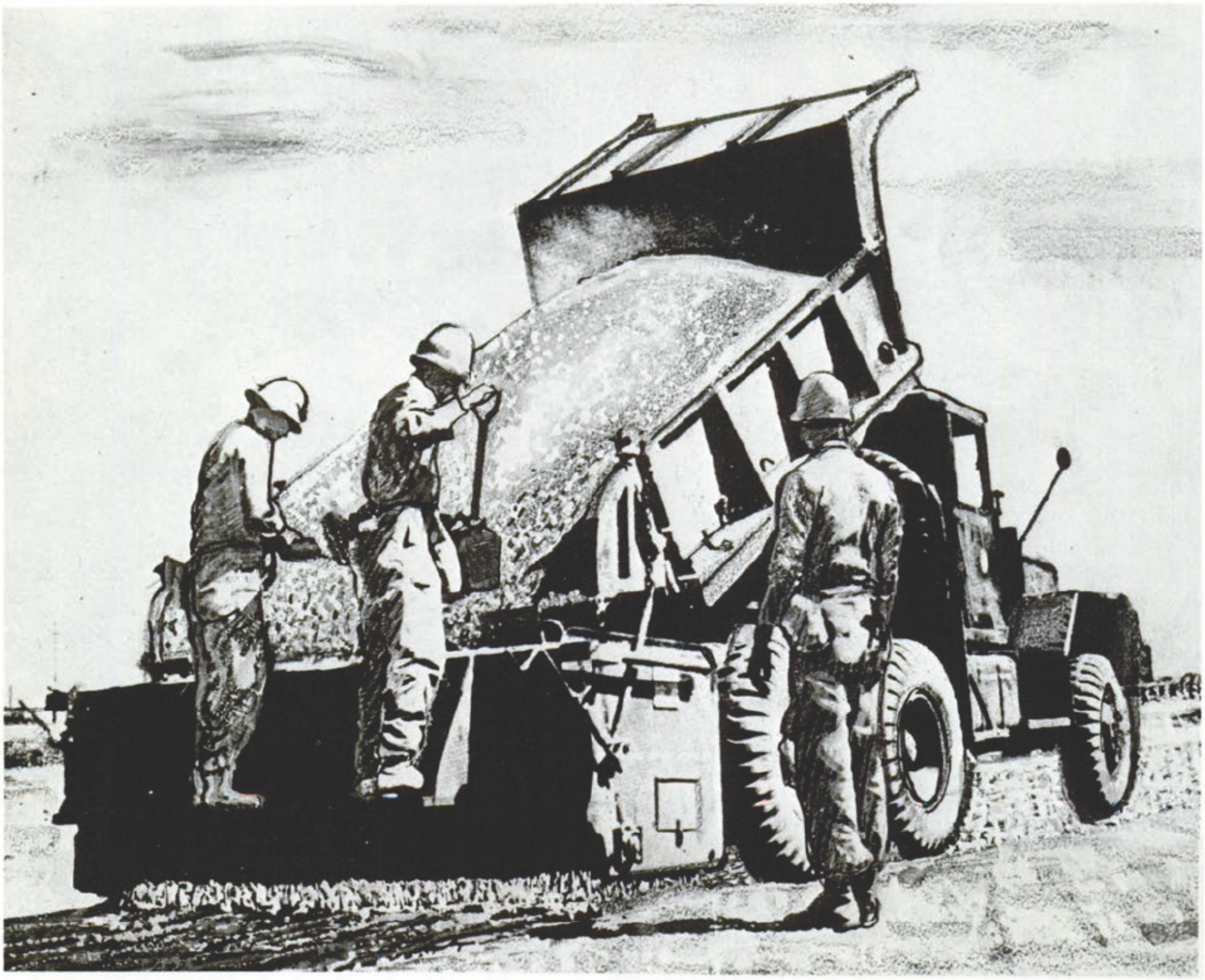
ROTARY SWEEPER

The rotary sweeper, also called a rotary broom, is one of the tractor attachments. It is used to remove the dust from the surface of the existing pavement prior to paving to ensure proper bonding between the newly laid asphalt and the old pavement. If paving is to be done on a prepared base course, the dust layer may be eliminated either by sweeping with the rotary sweeper or by wetting the base course and recompacting.

ASPHALT PAVING SAFETY

In bituminous paving operations, the chief danger is the likelihood of being burned by hot mix. If you are assigned to assist with handling hot bituminous mix or hot asphalt, remember to wear gloves, goggles, safety boots, and suitable heavy clothing to prevent serious burns. Trousers also should be either tucked-in or fastened tightly around your boots.

Be alert at all times when working around heating devices for probable hazards, such as



143.53
Figure 3-31.—Aggregate spreader.

accidental tipping, flash fires, and similar hazards. You must be familiar with the operation of the fire extinguisher provided in the location of the heating device. If you are directed to clean hot equipment, such as the aggregate dryer, allow it to cool sufficiently before attempting to work on it.

Another danger is the possibility of being pinned or run over by moving equipment, such as dump trucks, front-end loaders, asphalt finisher, and the like. DO NOT ever position yourself between machines of this type when in operation; for example, between the asphalt finisher and the haul trucks.

CHAPTER 4

EQUIPMENT MAINTENANCE

Consider all the different kinds of motor vehicles and construction equipment used by the SEABEES, and you can readily see the great and continuing need for Construction Mechanics. No matter how well-built a car, truck, tractor, or other piece of transportation equipment, nor how good the user maintenance, sooner or later you can look for mechanical failures or faulty conditions that require repairs or adjustments. When something goes wrong, it is usually the Construction Mechanic's job to locate the trouble and make whatever repairs or adjustments are needed to get the machine back on the job in good operating condition.

Preventive maintenance is another important phase of the Construction Mechanic's job. Preventive maintenance involves keeping equipment in good repair by proper operation, careful servicing, and timely minor maintenance, so as to delay or, where possible, prevent breakdowns and extensive repairs. To keep emergency repairs and breakdowns to a minimum, preventive maintenance inspections and services should be provided on a regular scheduled basis. Bear in mind that preventive maintenance is essential to maximum efficiency and full life expectancy of the equipment.

There are many basic skills and knowledges required of a Construction Mechanic. He must understand the principle of internal combustion as it applies to diesel and gasoline engines. He must know how to maintain and repair the various components of a chassis. He must be able to keep brakes in good operating order. He must thoroughly understand the operation of power trains. And he must be able to maintain the automotive electric system.

As a Constructionman, you will not have to know all of this. With respect to internal combustion engines, it will be enough for you to know that internal combustion means the burning of a mixture of fuel and air in a small enclosed space; in both diesel and gasoline engines, this burning takes place in the engine cylinder.

You should know that the chassis of an automotive vehicle includes the frame and all major attachments to the frame except the body. You will find, however, that most mechanics who refer to the chassis mean the suspension, steering, braking system, and power train of the vehicle; the engine is generally treated as a separate component.

Repairing brakes is beyond the scope of the CN's duties. You should know, however, that brakes may be mechanical, hydraulic, air, electric, or vacuum type; that the hydraulic type is most commonly used on automobiles, station wagons, and carryalls; and that a brake pedal which goes all the way to the floor indicates trouble in the brake system.

The power train of a vehicle is the mechanism that carries the power of the engine to the driving wheels. You should understand that the power train includes the clutch, transmission, transfer case, differential, connecting U-joints, and drive shafts. Vehicles with an automatic transmission usually do not have a clutch.

An automobile's ignition system, lighting system, starting system, and many accessories (such as radio, heater, and cigarette lighters) depend upon electricity for operation. Most heavy construction equipment also depends upon electricity for operating starting systems and accessories. The key components of a vehicle's electrical system are the battery, the generator, and the voltage regulator. On current model vehicles, an alternator replaces the generator. If any of these do not work properly, the entire system breaks down. As a CN, you will not often work with the generator or the voltage regulator, but you may have to service and maintain batteries. You will also have to do such work as replacing defective bulbs and burned out fuses. This chapter describes these operations.

THE AUTOMOTIVE GARAGE

As a Constructionman, you are likely to be assigned to the automotive garage or shop. This will provide a good opportunity for you to gain a lot of valuable and varied experience, because many kinds of automotive repairs and services are made in the garage (rather than in the field). You will probably be called upon to assist in the lubrication of vehicles as part of regular scheduled preventive maintenance servicing. Other duties will entail the servicing of batteries by checking the specific gravity of electrolyte and cleaning battery terminals and cable clamps. Changing tires and patching inner tubes will also be an important part of your job. Fueling vehicles, changing oil, and shop housekeeping are among the other duties which you can expect to perform at Constructionman level.

In a large, well-equipped shop, you will find many types of handtools, power-operated machines, and special-purpose equipment. In performing basic duties, you will use some of the handtools. A number of handtools which you will need for specific jobs are covered in this chapter. While you may not use many power tools or much special-purpose equipment, it is to your advantage to understand their purposes and to know what precautions to take when working around them. Power tools commonly used in the garage — to mention a few — include the drill press, bench grinder, arbor press, and lathe. Many types of special tools for servicing and repairing equipment often are available at a garage handling other than routine maintenance and repair jobs on motor vehicles and construction equipment. For instance, if your shop makes repairs to automotive bodies you will likely find such tools as power saws, power hammers, and metal shaping tools. Remember that there is a lot you can learn about the operation of the power machines and special tools available in your shop by studying the manufacturers' manuals on them and by closely observing the experienced mechanic as he uses them in his work.

GENERAL SERVICING OR MAINTENANCE

All motor vehicles require a certain amount of servicing or maintenance to keep them in safe and efficient operating condition. As a mechanic's helper, your main duties will probably include hoisting and jacking, housekeeping, and other basic tasks concerning the lubrication of vehicle parts; changing oil; fueling vehicles; and adding battery and radiator water when required.

LUBRICATION

Periodic lubrication not only prolongs the useful life of vehicles but also helps keep them in peak operating condition. Lubrication cleans and cools moving parts of the vehicle, reduces friction between these parts, and acts as a sealing agent. A good lubrication job requires selecting the proper lubricants and applying them in a sufficient amount, in the proper places, to vehicle parts.

Your shop will probably carry a number of different Navy-approved standard lubricants. Most likely, a lubrication chart also will be available showing what parts on the vehicle to lubricate and where they are located. Vehicle manufacturers provide the lubrication charts, which are similar to the one shown in figure 4-1.

Various types of grease guns and other dispensers of oils and greases are used in lubricating construction equipment and vehicles. In a well-established repair shop, such as the kind you will find in a public works center, permanently installed lubricating equipment of the type shown in figure 4-2 is generally available. This type of lubricating equipment uses air pressure to force grease through the fittings. At advanced bases or in field repairs of heavy equipment, however, hand-operated grease guns like those shown in figure 4-3 are generally used. In fact, some commands require that nearly all pieces of construction equipment be equipped with a hand-operated grease gun to enable the operator to lubricate some fittings on the equipment daily. To help ensure use of the right lubricant, each dispenser is marked to show the grade and type of lubricant it contains. Most lubrication jobs are performed during regular scheduled inspections, as called for in the manufacturer's service handbook.

Under the supervision of a qualified mechanic, you may have occasion to use grease guns for applying lubricants to vehicle parts. You must be careful when using a hand-operated grease gun, because it is capable of producing extremely high pressure that might cause some damage to grease seals and other delicate parts of a fitting. Your main duties, at least to start with, will probably consist of basic tasks such as hoisting

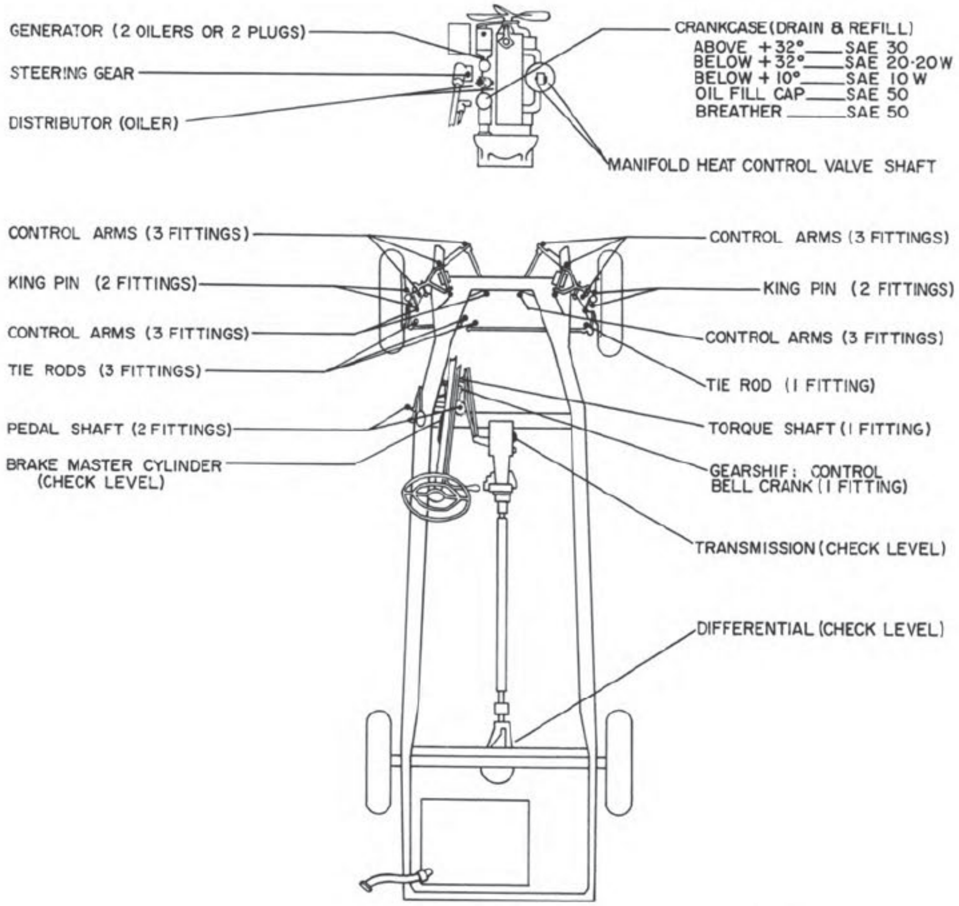


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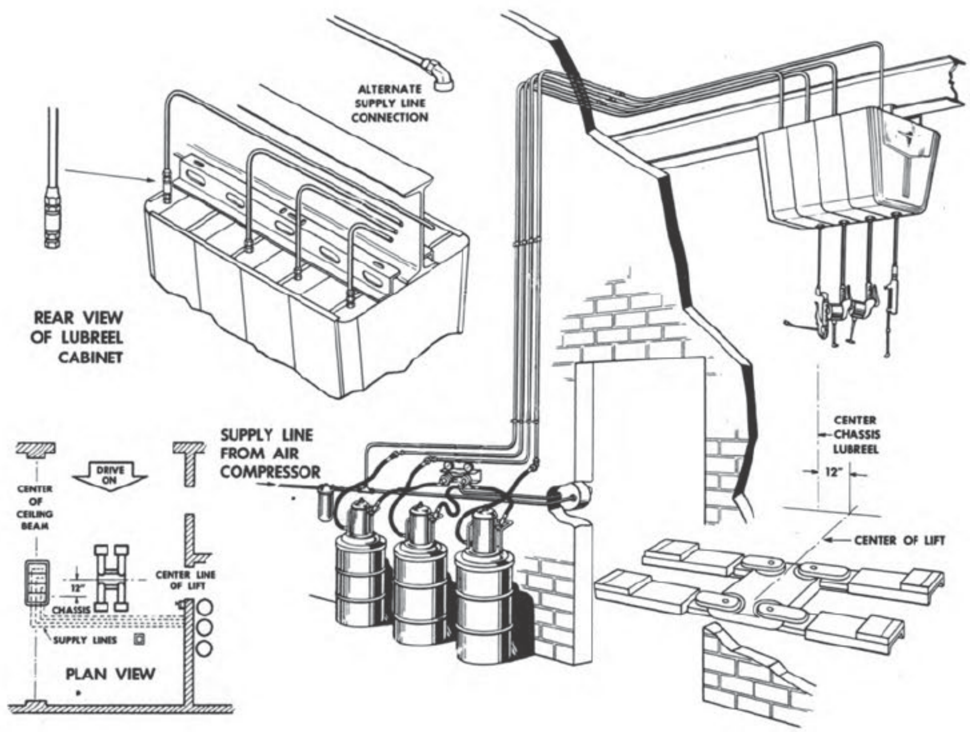
Figure 4-1.—A typical chassis lubrication chart.

or jacking up vehicles to be lubricated and shop housekeeping.

Various types of hoisting and jacking equipment are used in automotive shops. In some shops you will find HOISTS capable of lifting the vehicle completely off the ground or floor to permit working underneath. Chain hoists, fixed to a structure over a grease pit, will not lift a vehicle as high as an electric, pneumatic, or hydraulic hoist. Chain hoists are commonly used at advanced bases. Permanent bases are equipped with hydraulic, pneumatic, and electric hoists.

JACKS frequently are used to relieve the vehicle body weight from chassis parts requiring lubrication. Before raising a vehicle with a jack, block the vehicle so that it cannot move. The jack should always be set on a solid footing. Place the jack so that the swing of its handle will be unobstructed.

STEEL RACKS, or SAFETY STANDS, are mighty useful safety devices in any automotive garage or repair shop. The steel racks can be adjusted to different heights. After raising the vehicle with a hand jack or service jack, safety stands must be placed under the frame, axles, or spring seats (the location depending largely upon the job to be done) before any work is started on the vehicle. The weight of the vehicle must be lowered slowly onto the stands; make sure that the points of supports are firmly in place. The steel racks support the car at the desired height, and hence provide added safety protection while work is done on the vehicle.



81.17X
Figure 4-2.—Permanently installed lubricating equipment.

81.16X
Figure 4-3.—Hand operated grease guns.

NEVER work under a vehicle supported only by the jack or hoist. Hydraulic, pneumatic, and electric hoists are equipped with automatic safety locks. Make sure that these automatic devices are in good operating condition before working underneath the vehicle.

A small shop or maintenance area without hoisting equipment is usually provided with pits, over which the vehicle may be driven, and from which the undercarriage of the vehicle may be lubricated.

GOOD HOUSEKEEPING is especially important in the area where vehicles are being lubricated. Keeping the area clean will probably be one of your main responsibilities. With safety in mind, make a special effort to remove excess grease from fittings and to wipe up all lubricants that drip onto the floor. Remember that grease on the outside of a fitting does not lubricate, and oil or grease in puddles or in gobs around the grease rack can cause serious injury. So, look for and remove spilled oil or grease that drops from chassis parts.

After lubrication, you may have the job of cleaning and refilling grease guns so they will

be ready for use when next needed. Consider it your responsibility, also, to see that the grease guns and other lubricating equipment are stowed in their proper places.

CHANGING OIL

Oil changes should be made in accordance with the manufacturer's service handbook, and at other times if directed by your supervisory petty officer. On most of your equipment, the grade and quantity of the oil to be used will be indicated on a plate or chart in the cab. The oil should be changed more frequently in cold weather and under dusty or other unfavorable conditions.

In making an oil change, first start the engine and let it warm up; then drain the used oil from the lubrication system. The warm-up period will thin the oil and stir up the sludge and foreign matter in the oil pan. Cold oil is thick and does not drain readily; also, foreign matter tends to stick to the sides of the oil pan when the engine is cold. Figure 4-4 shows you the circuit through which oil moves to reach every moving part of the engine in a pressure feed lubrication system. After the oil is replaced, be sure that the drain plug is tight, and that the filler cap, through which the crankcase is ventilated, is clean. When replacing the drain plug, be careful NOT TO CROSS-THREAD the plug, and DO NOT exert more pressure

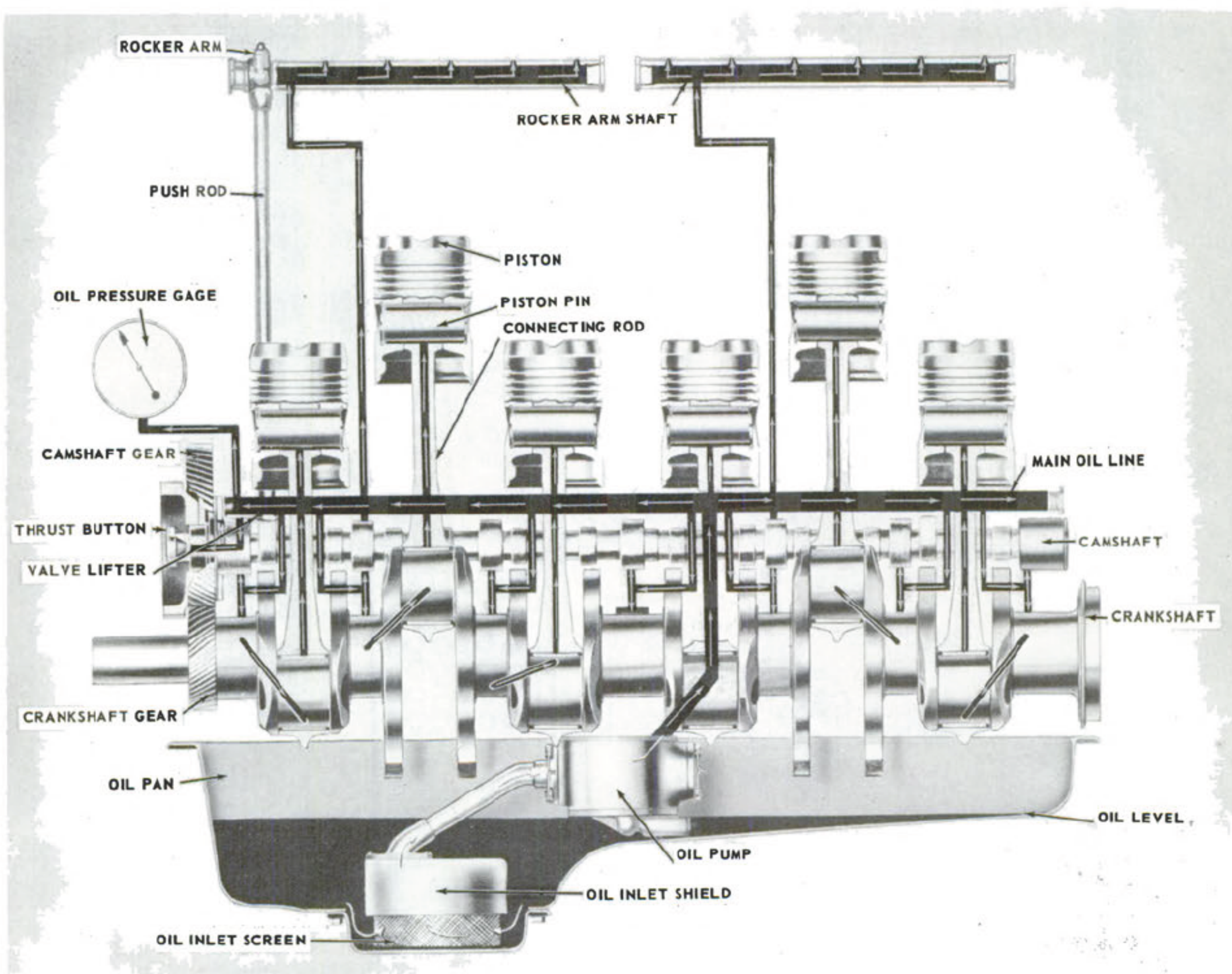


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Figure 4-4.—Diagram of basic units and oil passages of a pressure feed lubrication system.

than necessary to tighten it. These are the common causes of stripping the threads in the oil pan. In late model vehicles, the pan is generally made of soft metal; that is why you should be extra careful.

Above the pump in the oil line, you will find the OIL FILTER. (See the different types of oil filters shown in fig. 4-5.) The oil filter removes solid contaminants, such as metal chips, carbon, dust, and grit, from the oil, but not liquid contaminants, such as water, gas, and vapor, that may find their way into the lubrication system. In other words, the filter helps keep the oil clean and prevents entry into the engine of most of the very small foreign particles that could impair its efficiency.

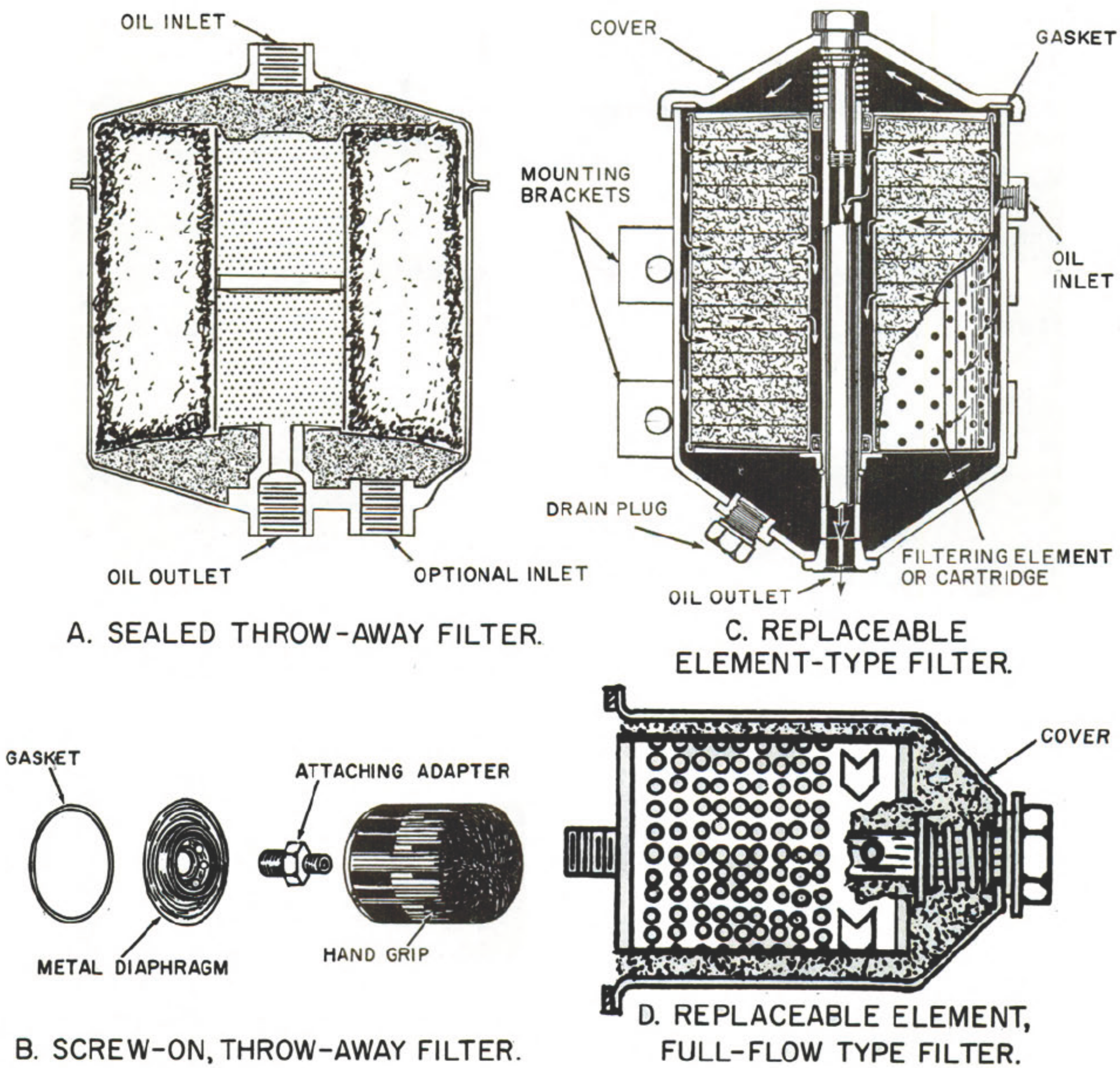

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Figure 4-5.—Different types of oil filters.

Three types of oil filter systems are available. They are the bypass, full-flow, and shunt types. The first two are the most commonly used, with the full-flow being the most popular.

The bypass system uses one of three types of oil filter: (1) the sealed, throw-away type, (2) the screw-on, throw-away type, or (3) the replaceable element type. The full-flow and shunt systems use the replaceable element type or the screw-on, throw-away type. To service these filters, you proceed as follows:

1. The SEALED, THROW-AWAY FILTER (view A, fig. 4-5) is replaced as a complete unit. Disconnect the oil line at the filter, detach the filter from its bracket, and remove the brass fitting from the filter housing; insert a plug in the brass fitting when removing it as brass is malleable (easily bent) and may be crushed under excess pressure. Throw away the filter. Install the brass fitting in the new filter and install on the engine. Fill the crankcase to the full mark on the dipstick with the proper grade and weight of oil. Start the engine, observe the oil pressure gage (if so equipped), and check for leaks around the filter.

2. The SCREW-ON, THROW-AWAY FILTER (view B, fig. 4-5) is also replaced as a complete unit. Unscrew the filter from the base by hand or by use of a strap wrench, and throw the filter away. Wipe the base clean with a cloth, coat the rubber gasket on the filter with a light coat of oil, and screw a new filter onto the base by hand only, tightening at least half a turn after the gasket contacts the base. Fill the crankcase to the full mark on the dipstick with the proper grade and weight of oil. Start the engine and observe the oil pressure, and check for leaks around the oil filter.

3. To SERVICE REPLACEABLE ELEMENT FILTERS (views C and D, fig. 4-5), you remove the fastening bolt, lift off the cover, and remove the filter shell. Remove the gasket and throw it away. When removing the oil filter on the full-flow or shunt system, place a pan under the filter to catch the oil. Take out the old element and throw it away. Throw away the gasket from the top and bottom of the center tube if they are present. Place a pan under the filter and remove the drain plug if the filter is used in the bypass system. Clean the inside of the filter shell and cover. Install metal supports and a new bottom tube gasket. Insert a new element and a new top tube gasket. Insert a new cover or housing gasket (make sure that the gasket is completely seated in the recess). Replace the cover or housing and fasten the center bolt securely. Fill the crankcase to the full mark on the dipstick with the proper grade and weight of oil. Start and idle the engine. Check the oil pressure immediately and inspect the filter for oil leaks.

The final step in the procedure is to mark the mileage on the sticker so that the element of the oil filter will be replaced at the proper interval.

FUELING VEHICLES

Only experienced personnel should be allowed to fuel motor vehicles and they should have a thorough knowledge of the hazards involved. Some of the major precautions that should be carefully observed in carrying out fueling operations are as follows.

Before adding fuel to a vehicle, make sure that the engine and vehicle lights are turned off. Place the hose nozzle firmly in the tank, and make sure there is contact between the nozzle and tank while gasoline is being added to the tank. The hose nozzle must be grounded to the tank because of danger of sparks from static electricity during the filling process. Take special care that fuel tanks are not filled to overflowing. Do not withdraw the hose nozzle until the flow of gasoline has stopped, and drain the hose nozzle thoroughly before removing it from the tank. To minimize the effects of gasoline fumes, the face should be turned away from the fuel pipes while making deliveries of gasoline. (See fig. 4-6.)

During fueling, do not smoke or light a match or lighter for any reason. This same rule applies to the operator or others who may be in the vicinity of fueling. Make sure, also, that there is no open flame in the vicinity.

UNDER-THE-HOOD SERVICING

When vehicles are filled with fuel, it is good practice to raise the hood and check the water in the radiator and in the cells of the battery. (See fig. 4-7.) If the water in either is low, bring it up to proper level.

In filling the battery cells, use distilled water or chemically analyzed water approved for battery use. Battery water should be kept in a covered glass, earthenware, hard rubber, or plastic container.

The oil supply also should be checked before closing the hood. If the dipstick shows a low

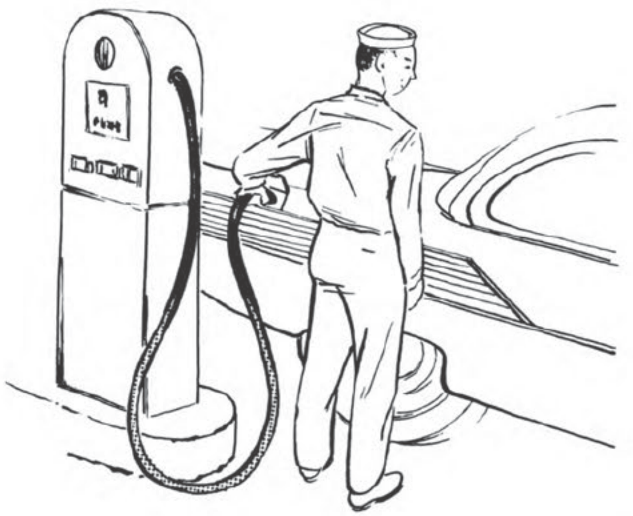

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Figure 4-6.—Turn face away from fuel nozzle while making deliveries of gasoline.

supply, add oil of the proper grade to bring the level up to the full mark on the dipstick. In checking the oil, follow the procedure explained in chapter 2.

Regular servicing of the radiator by adding water is not a difficult task. In doing this, make sure you develop the habit of replacing the radiator cap after adding the water. You will find, of course, that servicing the radiator is not always just a routine matter of adding water. For instance, sometimes the water supply in the cooling system of a vehicle gets unusually low and the radiator starts steaming. When this happens, you must exercise care in adding water to avoid possible injury to yourself and damage to the vehicle.

Before adding any water to a steaming radiator, make sure you let the engine cool sufficiently to prevent the possibility of cracking the cylinder block or head. Cracking is caused by the sudden contraction of the hot metal when contacted by cool water.

When a radiator is steaming, put a large rag over the radiator cap to protect your hands; then unscrew the cap a little at a time to let the steam escape gradually. (See fig. 4-7.) After removing the cap, add water SLOWLY while the engine is running.

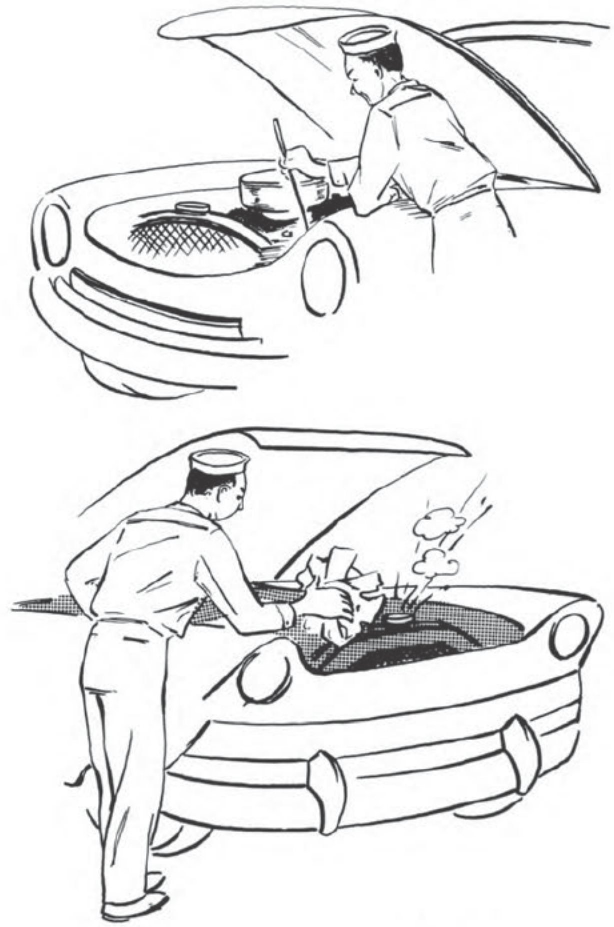

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Figure 4-7.—Under-the-hood servicing.

FUEL AND LUBRICANT SAFETY

The greatest hazard in working with fuels and lubricants is commonly attributed to fire. Fuels, in particular, are highly flammable, and safety precautions are essential when you are working around them. A lighted cigarette carelessly tossed into a corner of the shop can touch off a big fire in a matter of minutes. Carelessness, however, is not the only cause of fires; ignorance of safety precautions, or failure to observe them, also invites fires.

Oily rags tucked neatly out of sight may get by an inspection, but such stowage does not meet safety requirements. When not placed in

covered containers, oily rags can easily catch fire by spontaneous combustion. Therefore, you should ALWAYS see that such rags are placed in containers that can be closed.

Open containers of gasoline or kerosene give off flammable vapors and are therefore very dangerous. An engine with a gas leak also can cause flammable vapors by letting drops of fuel fall to the floor, where they form puddles. Unless these puddles are covered by sweeping compound or other absorbent material, they will give off invisible vapors which tend to concentrate just above the surface of the floor. If there is a strong odor of gasoline in the shop, open all doors and windows. These vapors must be dissipated and their sources removed, or else there will be constant danger that they will ignite through static electricity.

Classification of Fires

Accepted standard practice separates fires into three general classes: class A, class B, and class C.

CLASS A fires involve wood, paper, cloth, rubbish, and explosives. These fires are fought with water.

CLASS B fires involve substances like oil, gasoline, kerosene, and paint. These fires usually are fought with foam or fog.

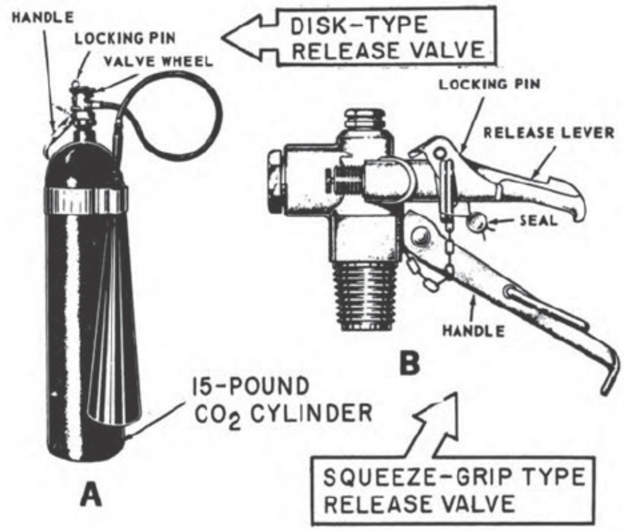
CLASS C fires are those involving electrical and electronic equipment. Generally, carbon dioxide (CO_2) gas is used in fighting these fires.

Carbon Dioxide Extinguisher

The portable 15-pound, carbon dioxide (CO_2) extinguisher shown in view A, figure 4-8 is very effective for putting out electrical fires and burning fuel or grease in confined spaces. The Navy standard CO_2 type extinquisher has a release valve like that illustrated in view B, figure 4-8.

To operate the portable 15-pound, CO_2 extinguisher, proceed as follows:

1. Carry the extinguisher in an upright position and approach the fire as closely as possible.
2. Remove the locking pin from the valve.
3. Grasp the horn handle. This handle is insulated to protect you against frostbite from the suddenly expanding CO_2. Squeeze the release lever to open the valve and release CO_2. Direct the flow of CO_2 toward the base of the fire. The maximum effective range of a 15-pound,



3.158

Figure 4-8.—(A) Portable 15-pound, CO_2 extinquisher with disk-type release valve. (B) Squeeze-grip type release valve.

CO_2 extinguisher is 5 feet from the outer end of the horn. This distance is reduced if the wind is against you and increased if the wind is with you. If possible, attack the fire from the windward side in order to increase the range and also to protect yourself from the heat of the fire. When the CO_2 is released, it forms "snow;" DO NOT touch this snow; it will blister your skin and may cause painful burns. Move the horn slowly from side to side and advance on the flames as they recede.

4. When conditions permit, close the valve. Continue to open and close the valve as the situation requires. When continuous operation is necessary, or when the valve is to remain open for recharging, slip the D-yoke ring on the carrying handle over the operating handle. The operating handle should be in the depressed position when you put on the D-yoke ring. The D-yoke permits continuous operation of the extinguisher, as long as any CO_2 remains. Once a 15-pound cylinder has been used, it should be recharged before it is returned to stowage. The process of recharging CO_2 cylinders should be accomplished in a well ventilated space and should be done under the supervision of an experienced petty officer.

CO_2 is most effective in closed areas. If there is a wind or draft, work upwind to prevent the CO_2 from being blown away before reaching

the flames. But remember, this gas is dangerous. Since it smothers and puts out fires by displacing or diluting oxygen in the air, the lack of oxygen could suffocate any person in the area. Therefore, no one should normally be allowed in a space where CO_2 has been released until the space has been aired for at least 10 minutes. If it is necessary to enter the space, wear approved Navy rescue breathing equipment.

A CO_2 extinguisher must be inspected monthly. The date of each inspection and the initials of the inspector are noted on the "Inspection Record (Fire Extinguisher)," NAVDOCKS 2072 form, attached to the extinguisher.

Foam-Type Extinguisher

The FOAM-TYPE extinguisher (fig. 4-9) has water in addition to several chemicals. When the extinguisher is not in operation, the water and the chemicals are separated from each other within the container. When you turn the container upside down to operate the extinguisher, the water and the chemicals mix to form a foam-like substance that smothers the fire on which it is sprayed. This extinguisher is especially useful for blanketing "liquid" fires on floors and machines. It is not recommended for electrical fires because of the danger of fouling the electrical system and causing shock.

Be careful not to upset foam-type extinguishers. Once upset or inverted, they will discharge all of their contents, leaving a sticky mess to be cleaned up.

Like the CO_2 extinguisher, the foam type should be inspected monthly. Corrosion around the nozzle indicates that the contents of the extinguisher have lost their strength and that the extinguisher needs recharging. Normally, foam extinguishers of the 1 1/4- and 2 1/2-gallon capacity should be discharged and recharged once a year.

Dry Chemical Extinguisher

DRY CHEMICAL extinguishers used as an agent for combating Class B flammable fuel fires uses "Purple-K-Powder" dry chemical. This chemical consists entirely of crystals of potassium bicarbonate, which is a non-toxic material closely related to the old baking soda extinguishing agent (sodium bicarbonate) but fully twice as powerful

81.40
Figure 4-9.—Foam-type (portable) fire extinguisher.

in fire killing ability per pound. Like carbon dioxide, however, it is a temporary extinguishing or smothering agent. Fires in fuels, like gasoline or hot diesel oil, can be quickly extinguished with P-K-P agent but unless ALL the fire and nearby sources of ignition are fully extinguished, the flame can flash back, and the fire will quickly return to its original intensity. For this reason, it is always advisable to back up dry chemical (or carbon dioxide) on hot Class B fuels with a permanent extinguishing agent such as foam.

Be Prepared for Emergencies

The Navy is constantly developing new methods of putting out fires; therefore, do not be surprised to find in your shop new types of equipment not discussed here. NOW is the time to locate the extinguishers in your area and to make certain that you know how to use them. And remember to respect the sign FOR FIRE ONLY; it may save your life.

You should also know the location of the nearest fire alarm box and how to get in touch with the fire crew. The fire crew will have to handle fires too big for portable extinguishers; the fire crew must also be called when no extinguisher is available. All fires must be reported to the Fire Marshal.

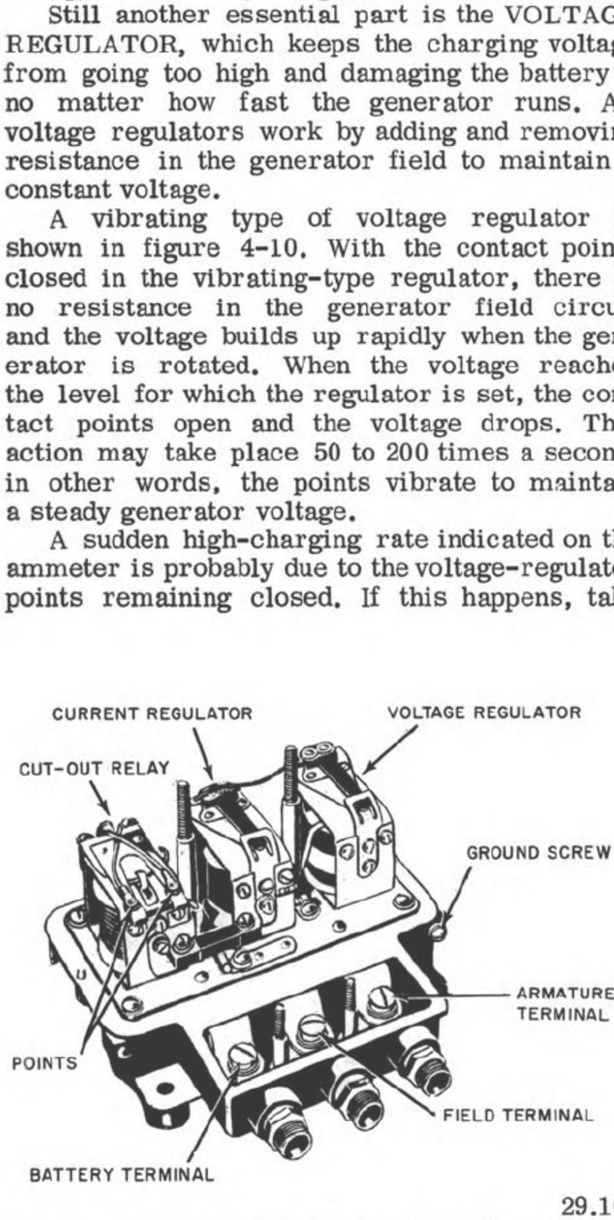
SERVICING ELECTRICAL SYSTEMS

Today's vehicles have quite a number of accessories that are electrically operated. These accessories, to mention a few, include lights, heaters, radios, and starting motors. A vital part of the vehicle's electrical system is the GENERATOR (or ALTERNATOR) which produces the electricity necessary to operate these varied accessories. Another important part is the STORAGE BATTERY, which stores up the energy delivered by the generator.

Still another essential part is the VOLTAGE REGULATOR, which keeps the charging voltage from going too high and damaging the battery—no matter how fast the generator runs. All voltage regulators work by adding and removing resistance in the generator field to maintain a constant voltage.

A vibrating type of voltage regulator is shown in figure 4-10. With the contact points closed in the vibrating-type regulator, there is no resistance in the generator field circuit and the voltage builds up rapidly when the generator is rotated. When the voltage reaches the level for which the regulator is set, the contact points open and the voltage drops. This action may take place 50 to 200 times a second; in other words, the points vibrate to maintain a steady generator voltage.

A sudden high-charging rate indicated on the ammeter is probably due to the voltage-regulator points remaining closed. If this happens, take the equipment to the shop for repairs or adjustments. A number of other things may go wrong with the regulator; these troubles require the services of a qualified mechanic.



29.101

Figure 4-10.—Regulating unit with cover removed.

To keep the electrical accessories in the vehicle in good working order, the Construction Mechanic must have a reasonable knowledge of various electrical terms and of certain basic principles of electricity. He must be able to read wiring diagrams so that he can trace electrical circuits and locate sources of trouble that develop in the vehicle's electrical system. Among other things, he must also know the possible causes of common defects or troubles in the electrical system and what repairs or adjustments are needed to correct them.

The Constructionman is not expected to be an automotive electrician. There are certain basic duties, however, that the Constructionman can handle as a helper to the Construction Mechanic. These duties include checking the specific gravity of electrolyte in batteries; cleaning batteries; and changing lamp bulbs in automotive equipment.

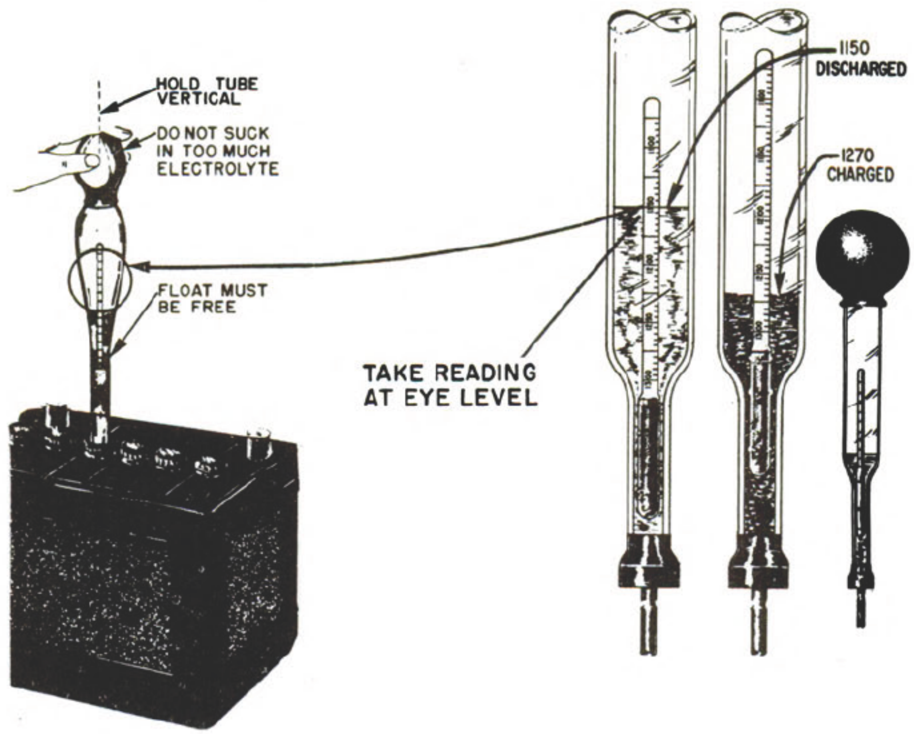
MEASURING SPECIFIC GRAVITY IN BATTERIES

You can tell a lot about a battery's condition by checking the strength of the electrolyte in each cell of the battery. The electrolyte strength is measured in terms of SPECIFIC GRAVITY. (Specific gravity means the ratio of weight of a given volume of a substance to the weight of an equal volume of pure water at a given temperature.) The electrolyte used in each cell of a storage battery is a mixture of sulphuric acid and pure water.

A point to remember is that when water is added to battery cells, it will tend to stay on top of the cells and an immediate reading will be inaccurate. Therefore, the battery should be charged for several hours after water is added before a reading is taken.

Remember, too, that the electrolyte in a cell should be at the normal level when the reading is taken. If the level is below normal the reading will be high. And, if the battery has been overfilled, the electrolyte has been weakened and the reading will be low.

To measure specific gravity you will use a hydrometer, the same or similar in type to that shown in figure 4-11. The hydrometer has a small weighted float, placed inside the glass tube of a syringe. The syringe has a rubber bulb on one end and a small rubber tube on the



4.135
Figure 4-11.—Using a hydrometer.

other. To take a reading, squeeze the bulb and insert the small tube into the cell. Hold the hydrometer in a vertical position, and release the bulb slowly until you have drawn enough electrolyte into the syringe to make the float move freely. To avoid incorrect readings, do not permit the float to touch the sides, top, or bottom of the syringe barrel. Read the hydrometer with the surface of the liquid level with the eye. Do not let the electrolyte drip on any part of your body or clothing. ALWAYS RETURN THE ELECTROLYTE TO THE CELL FROM WHICH IT WAS TAKEN.

When a battery is fully charged, you should get a specific gravity reading of about 1.250 to 1.300. When a battery is discharged, the specific gravity will be about 1.100 to 1.150.

Incidentally, in speaking of specific gravity of a battery, it is customary to omit the decimal point; for instance, a reading of 1.300 would be referred to simply as "thirteen hundred;" or 1.280 as "twelve eighty," and so on.

The hydrometer that you use will probably be marked to read specific gravity at only one temperature—that is at 80°F. Under normal conditions the temperature of your electrolyte will not vary much from this mark. However, large changes in temperature (either above or below 80°F) require a correction in your reading. When a correction of the specific gravity reading is necessary, report the matter to your supervisory petty officer.

CLEANING BATTERIES

The cables which carry the current from the battery are fastened to the battery terminals by metal clamps. Acid fumes from the battery cells react with the metal to form a hard, green-white deposit on the clamps and terminals which results in corrosion. Too, the deposit gets down between the terminal posts and the cable clamps and hampers the flow of current; this means a waste of energy.

To remove the green-white deposit from the cable clamps and terminals you will need a strong solution of bicarbonate of soda (plain baking soda) and water. In mixing the solution, use about 3 tablespoons of soda to a pint of water. After mixing, remove the cable clamps from the terminal posts and swab the solution on the parts using a stiff brush. The solution

will soften the deposit, which can then be scraped away with a stiff brush or a knife. When clean, rinse the parts with clear water and wipe dry with a rag; then reconnect the terminal posts.

In the cleaning operation, DO NOT permit the soda water solution to enter the cells. Make sure, also, that you do not get any of the green-white deposit on your skin or clothes. It is strong enough to eat a hole in a pair of trousers in a very short time. Another method of removing the green-white deposit is to apply a light coat of lubricating oil to the terminals and cable clamps. The lubricant, after being left on for a few minutes, will soften the deposit so that it can be removed easily with a stiff brush.

Clean off the top of the battery with a rag or stiff brush dipped in ammonia and water or in soda water. Plain water may be used. Be careful not to let any water get into the battery while cleaning it.

To help prevent corrosion in the future, coat the top of the battery and terminal connections completely with a Navy-approved plastic coating. If plastic coating is not available, waterproof the terminals by coating them in heavy, waterproof grease.

Now take a close look at the two cables which lead away from the battery. One of these cables should be "grounded" nearby to the engine. See that the bolt for this cable is tight.

The other cable extends to the starter, which is located at the rear of the engine. Check this cable to ensure that it is tight, securely clamped, and not frayed or corroded.

PREPARING ELECTROLYTE

In fieldwork, the preparation of electrolyte is seldom done nowadays. Since this is delicate work, premixed electrolyte is generally used in the field. In the event you do have occasion to prepare some electrolyte (in shopwork or in the field), you will be told how much water and sulphuric acid to use. But you will be expected to know what precautions to take when you mix them. First of all put on a rubber apron, protective goggles, and rubber gloves. Then, place the distilled water in a lead or earthenware container and pour the ACID INTO THE WATER. Avoid splashing. If water is added to concentrated sulphuric acid, the mixture may explode and spatter in all directions and may cause severe burns. Pour the acid into the water SLOWLY, stirring gently but thoroughly all the time. Large quantities of acid may require hours for safe dilution.

Let the mixed electrolyte cool to room temperature before adding it to the battery cells. Hot electrolyte will eat up the cell plates rapidly. To be on the safe side, do not add the electrolyte if its temperature is above 90°F. After filling the battery cells, let the electrolyte cool again because more heat is generated by its contact with the battery plates. Next, take hydrometer readings.

LIGHTING SYSTEM

The lighting system of automotive vehicles includes the headlights, tail lights, dash lights, dome lights, and signal and warning lights. Special purpose vehicles, such as ambulances and firetrucks, are equipped with special purpose lights. Some lighting systems are more complicated than others but utilize the same basic units.

Lamps and Bulbs

When operating at night, heavy duty (large) trucks and busses have so many lights burning in various locations that the average motorist has no trouble identifying them at a considerable distance. In addition to the headlights and tail lights, these trucks and busses require indicating lights, sometimes called position lights. These lights show the length, height, and width of the vehicle. Another important group is the auxiliary lights, which are convenience lights for the operator and passengers. Convenience lights include dash or panel lights and dome lights.

Each group of lights in a branch circuit of the lighting system is protected by a fuse or circuit breaker and is provided with a switch. Each light in the group is provided with one or more light bulbs which is rated for the particular circuit.

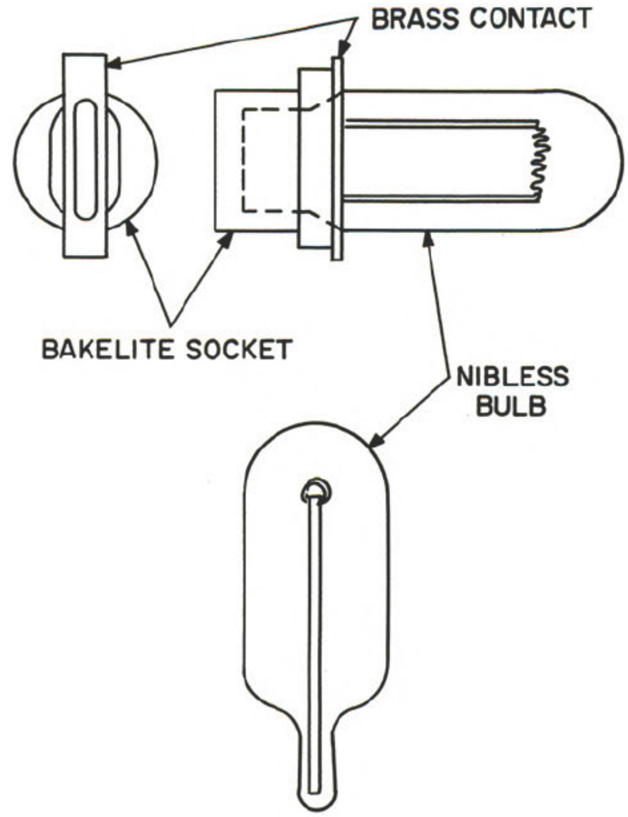
Light bulbs used in motor vehicles are made to operate on a low voltage current of 12 or 24 volts, depending upon the voltage of the electrical system used. Bulbs are rated as to size by the candlepower of light they produce. They range from small one-half-candlepower bulbs to large fifty-candlepower headlight bulbs. The greater the candlepower of the bulb, the more current it requires when lighted.

When you replace light bulbs in a vehicle, be sure the new bulb is of the proper rating. With the exception of the sealed beam bulbs, the other bulbs within the vehicle will be of

the single or double contact type, with nibs to fit bayonet sockets, as illustrated in figure 4-12. These bulbs have two nibs—one each on opposite sides. The bulb shown in view A, figure 4-12, has nibs that are aligned (even with each other), while on the bulb shown in view B, figure 4-12, the nibs are offset. The offset-nibbed bulbs are used for stop, tail, and turn signal lights. The nibs are offset to line up the correct filament in the correct circuit. The even-nibbed bulbs are used for ordinary illumination lights, such as the license plate lights, dash, and dome lights.

In late model automotive vehicles, you will find nibless bulbs that are very similar to the type illustrated in figure 4-13. The socket of a nibless bulb is connected to a dash-printed circuit. The bulb itself does not have a metal base. It is a press-fit bulb whose body resembles that of an ordinary camera flash bulb. The base is flat instead of cylindrical. It fits easily into the V-shaped socket, which is an integral part of the brass contact plate.

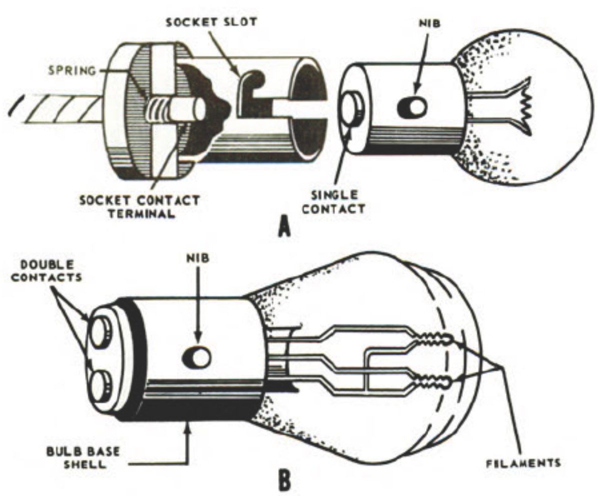
For protection of your hands when removing lens or light bulbs in a vehicle, use a piece of damp chamois, heavy rag, or regular bulb removers.



29.403
Figure 4-13.—Press-fit bulb and socket for dash-printed circuit.

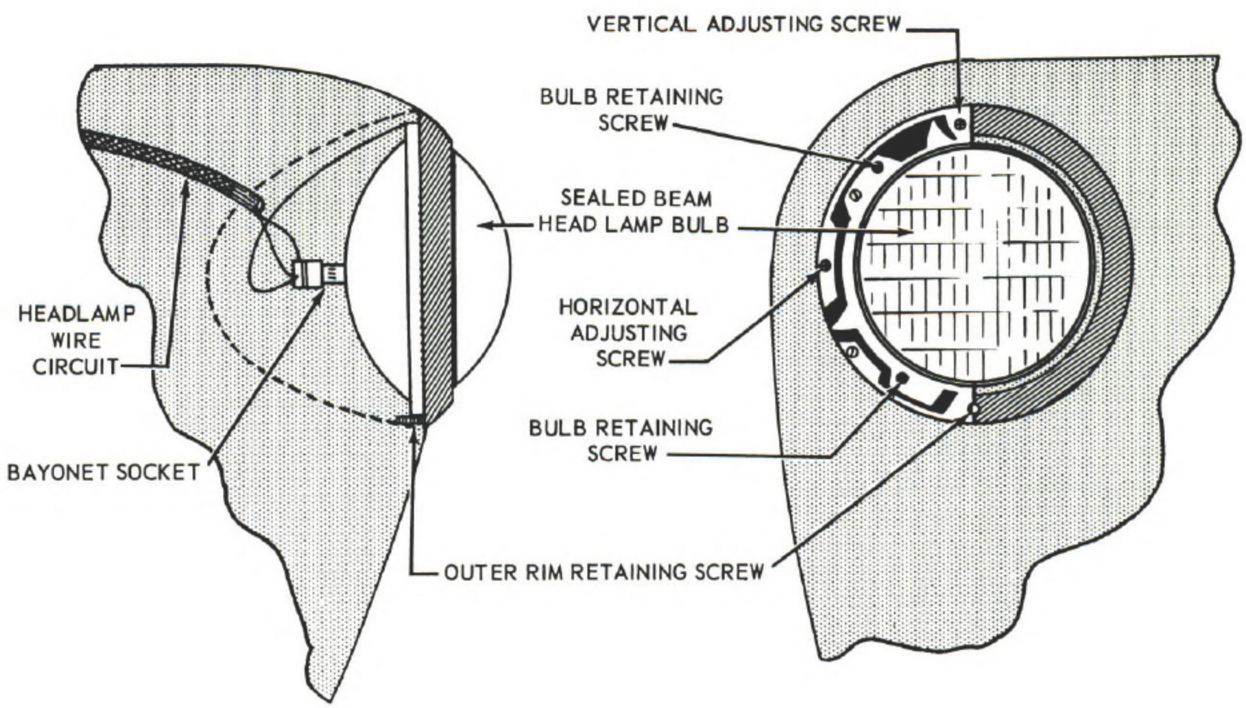
Sealed Beam

The sealed beam light is actually a large bulb. (See fig. 4-14.) The bulb consists of the lens, two filaments, and an aluminum-surfaced glass reflector. One of the filaments is used as the upper (or high) beam for country or open highway driving; the other is used as the low beam for oncoming highway traffic or city driving. When either of these filaments burns out, the complete unit must be replaced.



29.104
Figure 4-12.—(A) Single contact bulb. (B) Double contact bulb.

Newer vehicles (1958 and later models) generally have four sealed beam headlights, two on each fender (fig. 4-15). The outboard lights are typical sealed beam lights as described above and are marked with the numeral 2 molded on the upper portion of the glass lens. The inside, or inboard, headlights have one filament and are marked with the numeral 1 molded on the upper portion of the glass lens. (See fig. 4-15.) The inboard lights operate with the high beams of the outboard headlight for country driving. For city driving or for meeting oncoming open highway traffic the low beams of the outboard



2.124(29C)
Figure 4-14.—A typical sealed beam headlight installation.

headlights are used; the inboard lights are off when the low beams are on.

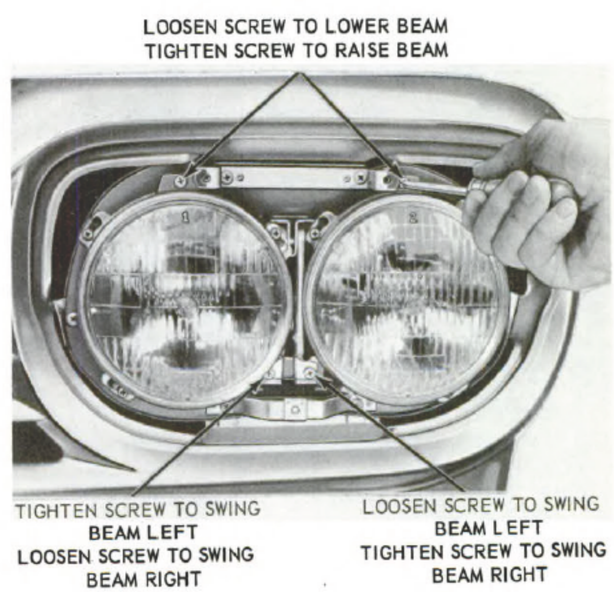
Headlight Alignment

To align the headlights of automotive vehicles there are various types of special alignment equipment. If you should have occasion to use special alignment equipment, carefully follow the manufacturer's instructions. Figures 4-14 and 4-15 show the location of the various adjusting screws used to properly align the sealed beam headlights.

FUSES AND CIRCUIT BREAKERS

Most switches are placed on the instrument panel close to the driver, and the fuses or circuit breakers can usually be found behind the instrument panel on a fuse block.

Fuses are placed in electrical circuits to protect wires and electrical accessories from excessive flow of current. Each circuit, or at least each individual electrical system, is provided with a fuse that has an ampere rating



2.124(2C)X
Figure 4-15.—Typical sealed beam headlights.

slightly over the maximum current required to operate the units. The fuse is made from metal with a low melting point, and forms the weakest point of the electrical circuit. In case of a short circuit or other trouble, the fuse will be burned out (melted) first and will open the circuit just as a switch would do. Circuit breakers serve the same purpose as fuses. Be sure, when replacing a fuse, that it has a rating equal to the one burned out, and that the trouble which caused the failure has been found and corrected.

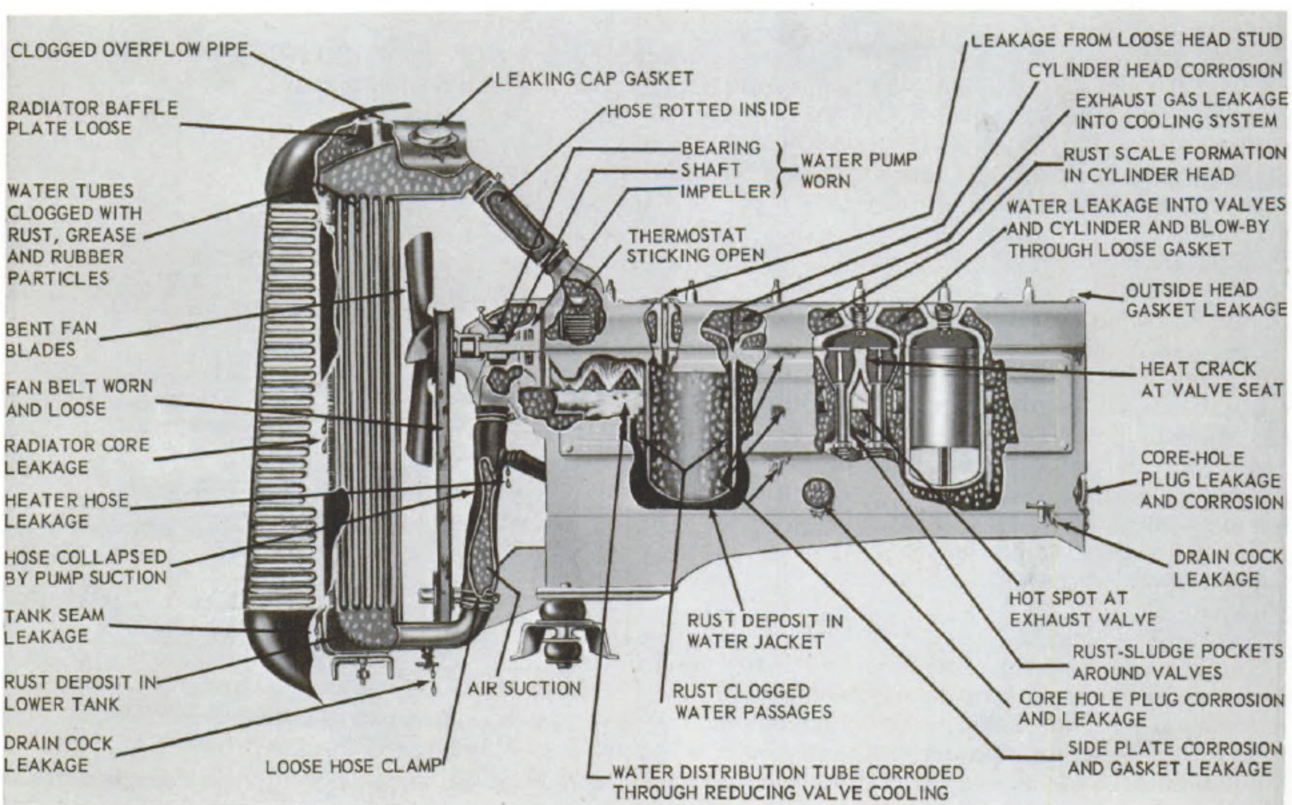
SERVICING COOLING SYSTEMS

Various types of servicing are necessary to keep the cooling systems of vehicles in good operating condition. Most motor vehicles have what is called a water-cooling system. Its main parts include a water pump, radiator, fan, and thermostat. A close look at figure 4-16 will give you some idea of the cooling system's arrangement and the many things that can go wrong in its different parts.

There is a lot to be learned about automobile mechanics in the area of cooling systems alone. And, as a helper to the Construction Mechanic, one of the best ways by which you can acquire this knowledge is by watching skilled craftsmen at work. Observe the tools and materials they use and the step-by-step procedure they follow in making a particular repair or replacing some part in the system. Remember, also, to ask questions about points that are not clear to you; and, if you have an opportunity, put in some time on practice projects, in that way, applying what you have learned.

DRAINING AND FLUSHING

In the area of servicing cooling systems, there are several jobs which the Constructionman should be able to handle more or less on his own. These include draining and flushing



29.106
Figure 4-16.—Cooling system, showing likely trouble spots.

the cooling system, replacing defective hoses, and adding water to steaming radiators.

The cooling system should be flushed and cleaned at least twice a year. At some activities, it may be required more frequently than at others, depending largely upon the particular shop. The flushing operation is necessary to prevent excessive accumulations of rust and other corrosive deposits, which in time could clog or damage the radiator passages.

To flush the cooling system, start by opening the drain cock (fig. 4-16). In unscrewing the drain cock, be careful not to use excessive force because the welds around its base are liable to give way when forced. If ordinary turning by hand won't budge it, apply some penetrating oil on the screw to loosen the rust around it. Allow the oil to penetrate a few minutes, and then proceed to open the drain cock. Let the water out. Then close the drain cock and refill the system with water, to which an approved radiator cleaning compound has been added. Start the engine and let it run for at least 1/2 hour after it reaches operating temperature. Now shut off the motor, drain the radiator again, refill with water, and run the engine for about 5 minutes. After draining this water, refill the radiator with soft water, adding a rust preventive and, if the weather requires, an antifreeze solution. The addition of rust preventive is recommended especially when filling the cooling system of a new car for the first time.

CLEANING RADIATOR AIR PASSAGES

Clean the radiator air passages of insects, dirt, and other foreign matter. For best results, blow out the radiator air passages with compressed air. BLOW FROM THE ENGINE SIDE. Be careful in using the compressed air apparatus, because sudden bursts of air may damage the radiator cooling fins or other engine parts. Be careful also not to get hit in the eyes with flying particles shaken loose.

HOSES AND CONNECTIONS

Take a close look at the condition of the radiator hose and the heater hose, keeping in mind that a spongy feeling indicates interior deterioration and the need for replacement. In replacing a hose, make sure it is of the proper length and diameter. The diameter (inside dimension) is usually marked on the outside of the hose. Never use shellac to seal a leak in a hose—except in an emergency. See that hose clamps and drain cocks are tight.

Carefully check the radiator, as well as hose connections, for signs of water leaks. Also, observe the space under the parked vehicle for wet spots. Small radiator leaks can be repaired by a special sealing compound, which is added to the water in the radiator. If the radiator leaks badly, it must be removed from the vehicle and the leaking spots must be soldered. The soldering will be done by the duty mechanic, or if there is a separate radiator shop, all radiator repairs are done in it. Be sure to observe closely the preparation and soldering process, for pretty soon this job may be delegated to you.

OVERHEATING

An overheated engine is easy to recognize by the temperature gage reading, radiator boiling or steaming, or a knocking and laboring sound from the engine. Probable causes include not enough water in the system, defective thermostat, defective pressure cap, slipping fan belt, or a partially clogged radiator. If the trouble is a defective thermostat or slipping fan belt, a Construction Mechanic will probably make the repairs or adjustments required. If the pressure cap is at fault, he may have you replace it with a new one. When the trouble stems from a clogged radiator you may be asked to drain and flush the cooling system, following the procedure described above. In case of a low supply of water, the remedy is to fill the radiator to the proper level. You will recall that precautions to follow when adding water to a steaming radiator were given earlier in this chapter in the section "Under-the-Hood Servicing;" make sure you are familiar with those precautions and apply them carefully when the need arises.

ANTIFREEZE

When vehicles will be operated during freezing weather, it is important that an antifreeze be added to the cooling system that will prevent freezing in the lowest temperature anticipated. A good antifreeze is not subject to rapid evaporation—but leaks are a different matter. Before adding antifreeze, therefore, check hose connections to make sure they are tight and free of leaks. Most antifreeze solutions contain a rust and corrosion inhibitor. Without such an inhibitor, rust and corrosion would clog radiators and cause water-cooled engines to overheat.

Antifreeze solutions commonly used include methyl alcohol, ethyl alcohol, or ethylene glycol. Ethylene glycol is a permanent-type antifreeze; alcohol-base materials are less permanent. Alcohol-base antifreezes are cheaper, but a main disadvantage in using them is that they evaporate readily and boil at very low temperatures. It is recommended that none of the older types of antifreeze be used for longer than one season; that includes the so-called permanent-types as well as the nonpermanent types. Some of the older "permanent types" of antifreeze actually may prevent the coolant from freezing for several winters. What often happens, though, is that the coolant meanwhile has become highly acid and, hence, is corroding the cooling system.

Avoid mixing different types of antifreeze. Usually, when one type has been mixed with another there is no way of knowing the temperature at which the mixed solutions will freeze. Another danger is that their ingredients sometimes react chemically and cause a corrosion in the cooling system and a foaming that forces quantities of the liquid from the radiator.

TIRES AND TUBES

Pneumatic tires and inner tubes are designed to provide traction and to cushion the shocks of the road or terrain. Traction is provided by the natural friction of the rubber upon contact with the road or terrain, aided by the tread design of the tire.

Cushioning is provided largely by the air within the tube, or the tire itself if of tubeless design. Both tire and tube are flexible enough to "give" when a bump or chuckhole is struck, and they are able to resume their former shape immediately.

The materials used in fabrication of tires include rubber, natural or synthetic, to provide the required resilience and friction; cord fabric, cotton, nylon, or rayon, to provide strength; and beadwire to hold the tire in shape and keep the tire on the rim or wheel. Special tires use wire in the tread to increase tread strength.

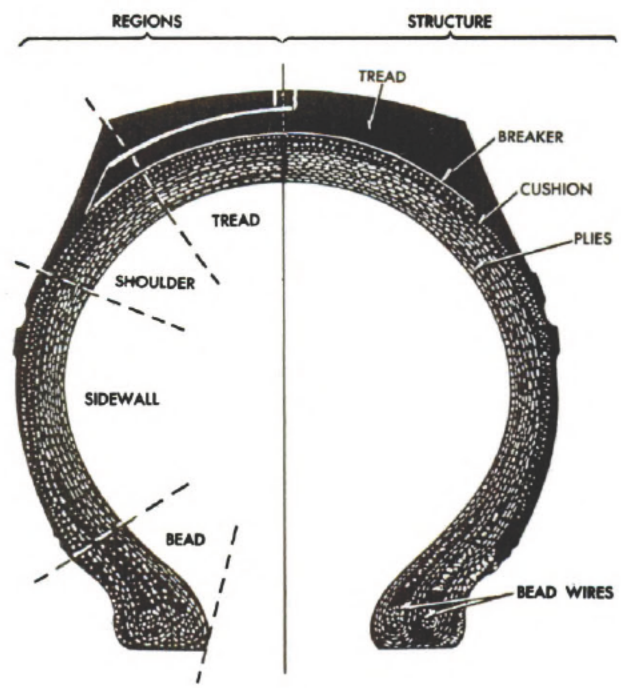
The inner tube consists of a natural or synthetic rubber bag, a stem for filling the tube with air, and a valve cap to keep dust from entering the stem. Different types of rubber or synthetic compounds are used for light, heavy, and earth-moving vehicles to meet the various on-and-off-the-road requirements. All inner tubes must be sturdy to withstand deterioration from heat, oxidation, constant flexing, and abrasion, but most important, they must be capable of retaining compressed air.

You will perform various duties, as a Constructionman, involving the servicing and care of tires and inner tubes. You will change tires that have gone flat or that show signs of being defective. You will patch inner tubes that have leaks, punctures, or other such defects. You may also assist frequently in the performance of various related duties, such as stowing tires and tubes for future use. It is extremely important that you know how to carry out these duties correctly and efficiently. This need is emphasized by the fact that tires and tubes are major safety factors which concern the lives of vehicle operators, as well as the lives of other persons.

TIRE STRUCTURAL PARTS

A cross-sectional view of a modern tire is shown in figure 4-17. The functions of the various parts are described in the following paragraphs.

The TREAD is a layer of rubber or synthetic compound, on the outside circumference of the



81.203

Figure 4-17.—Construction of a modern tire.

tire. The tread provides a wearing surface and it usually has a non-skid design to provide traction and help dissipate heat. The tread also protects the cords from cuts, bruises, and moisture. The tread extends over the sidewalls and shoulders of the tire for protective purposes.

The BREAKERS are layers of rubber-covered cords. They are similar to plies, except that the cords of breakers are more widely spaced. The breakers distribute road shock and prevent separation of the tread from the cushion.

The CUSHION is made of soft heat-resistant rubber, which absorbs road shocks and bonds the plies and breakers.

The cord PLIES are successive layers of cord body constructed of interwoven cords of cotton, rayon, or nylon. The plies are rubber-coated on both sides with a resilient rubber compound so that each ply is cushioned from the next. The cords used to make the fabric are selected for their high tensile strength, because they must withstand severe stress.

Another type of cord used is the wire cord. The wire cord consists of strong, shredded wire between the tread and the carcass (or casing) of earthmover tires. This protective layer of wire keeps most cuts from penetrating the carcass. It keeps tread cuts from growing by holding tread cuts close so that sand, dirt, and water do not enter and cause separation.

For many years, cotton cord was considered the best for all types of tires. Today, rayon or nylon cords are used in most tires, and are used almost exclusively for industrial and earthmover tires.

The term "ply rating," as defined by the Tire and Rim Association, is used to identify a given tire with its maximum recommended load when used in a specific type of service. It is an index of tire strength, and does not necessarily indicate the number of cord plies in a tire.

The BEAD anchors the tire to the rim, and may be considered the foundation of the tire. All cord plies are tied into the bead wire. The bead wire is an extremely important element in tire construction. Without the bead wire, a tire would not function. The air pressure, which is used to inflate the tire, forces the bead against the rim flange, to prevent any change of shape or slip on the rim. The pressure of the tire against the rim forms a seal for tubeless tires.

Various tread designs are used on tires to suit different functions. As we have special tires for snow driving in our automobiles, the SEABEES use different tread tires for earthmoving equipment, for implements, and so forth. Standard tires are used for normal SEABEE vehicles, such as sedans, trucks, and Navy buses. They are used where the vehicle is operated on improved roads and where the life of the tire is measured in mileage and tread wear. To know more about these various tread designs, take a close look at the different tires installed on the different automotive vehicles and construction equipment being used by your unit.

MARKINGS ON TIRES

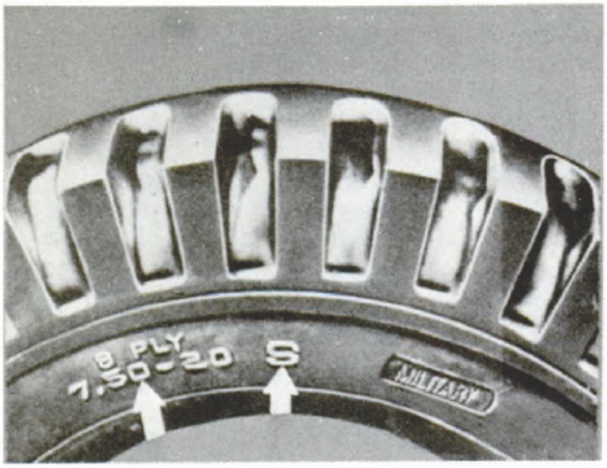
The sidewall of a tire is marked to show various items of information about that particular tire. Figure 4-18 shows you some of the markings generally used on tires for Navy vehicles.

The thickness of a tire is identified by the number of its plies—6 ply, 8 ply, 10 ply, and so on. The term PLIES refers to layers of rubber-covered cords that give the tire strength to resist internal pressures and to support heavy loads. Passenger vehicle tires usually have 4 or 6 plies; heavier duty tires may have as many as 14 plies. On late model passenger vehicles, some tires are marked "2 ply, 4 ply rating;" this simply means that, even though there are only two layers of rubber-covered cords in a 2-ply tire, its strength is comparable to that of a 4-ply tire.

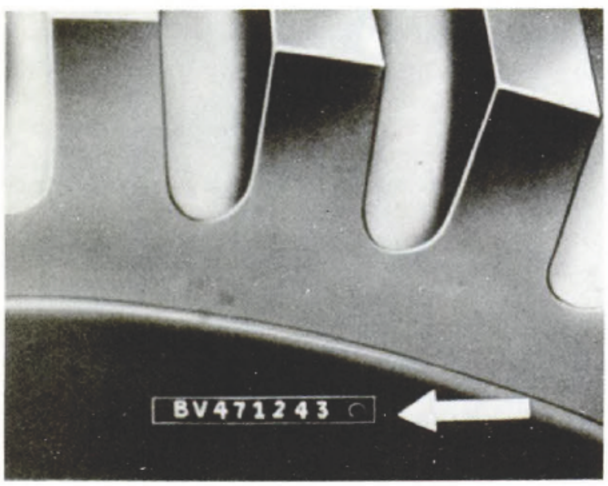
Another marking, as illustrated in figure 4-18, is that used to indicate the cross-sectional diameter of the tire and the size of the rim it will fit. For example, take a 2-ton truck tire with the marking 7.50-20. The first number, 7.50, designates the width of the tire in inches, when measured from sidewall to sidewall, when the tire is properly mounted on the rim and inflated, but not carrying a load; the second number, 20, is the ID (inside diameter), in inches from bead to bead.

Synthetic tires usually can be identified by a red mark three-quarters inch in diameter, or by the letter "S" on the sidewall. You will see this marking next to the tire size mark.

Another marking you should recognize is the SERIAL NUMBER of the tire (fig. 4-18). All tires have a serial number as a means of identification. It is generally located by the bead, and identifies the mold in which the tire was constructed. The serial number also serves as identification for tire warranty purposes when commercial tires are used on Navy motor vehicles.

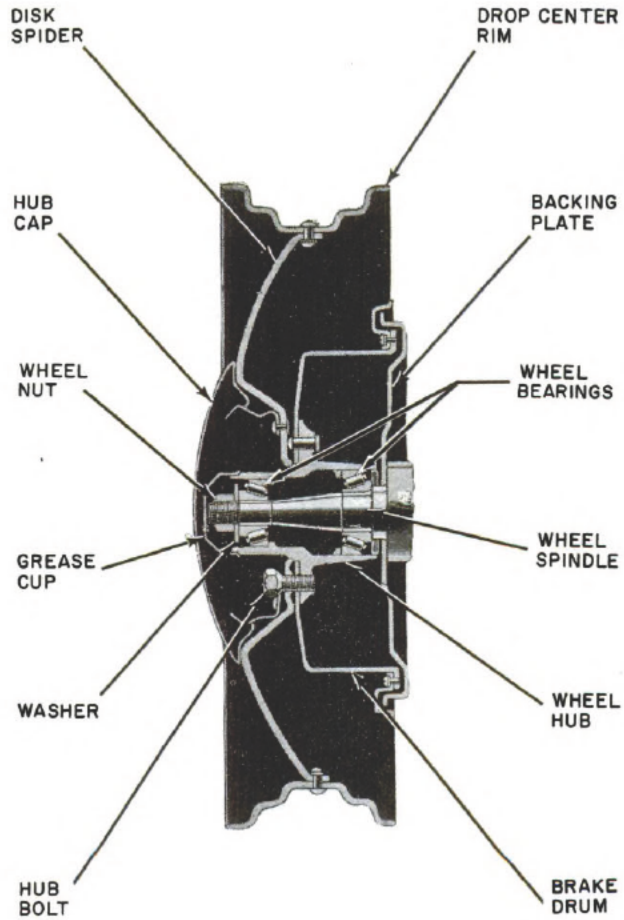


IDENTIFICATION OF SYNTHETIC TIRES WITH SIZE AND PLY MARKINGS



TIRE SERIAL NUMBER

29.107
Figure 4-18.—Tire markings.



29.108
Figure 4-19.—Cross section of a disk wheel.

CHANGING TUBED TIRES ON DISK WHEELS

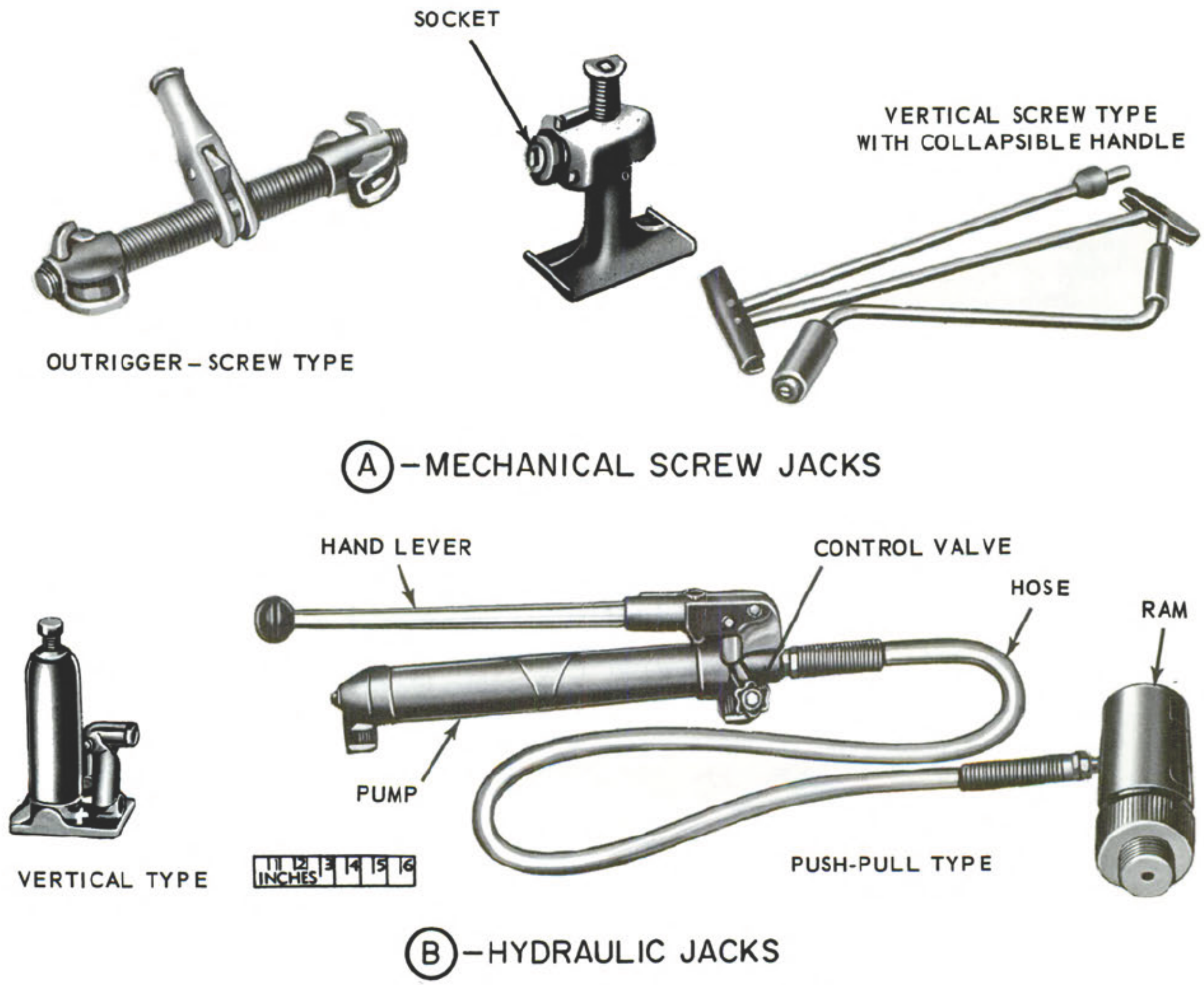
Most modern passenger cars and light or medium trucks have the tire and tube mounted on steel disk wheels. (See fig. 4-19.) The drop center rim, which holds the tire and tube, is riveted to the disk. Therefore, to change the tire, you usually remove the entire wheel, rim, tire, and tube as a single unit. For clarity, we should point out that in this part of our discussion we are mainly interested in how to change a tubed tire mounted on a disk wheel with a drop center rim. Of course some of the operations described for changing disk wheels may also apply in general when changing tires on vehicles equipped with other types of wheels or rims. In the following subsections, a few important pointers are given on changing tires on vehicles equipped with dual disk wheels and spoke wheels. A brief discussion also is included on changing tubeless tires.

To change a tire you will need a jack or other hoisting device which will permit lifting one side or end of the vehicle so that you can remove the wheel or tire. When changing tires

on automobiles and light trucks you may frequently use a mechanical or a hydraulic jack similar to one of those shown in figure 4-20. Although your main use of these jacks will be in connection with changing tires, it is important that you also know their other uses and capabilities. As a mechanic's helper, you may also use these jacks for purposes other than raising the vehicle to change tires. Make sure you are familiar with the characteristics and the method of operation of each type of jack available in your shop.

Jacks are used to raise or lower heavy loads for short distances. Some jacks are used for pushing and pulling operations, or for spreading and clamping. These jacks are available in capacities from 1 1/2 to 100 tons. Small capacity jacks are generally operated through a rack bar or screw, while those of large capacity are usually hydraulic. Hydraulic jacks of 3-, 5-, 8- and 10-ton capacity are provided in "0" kits of new vehicles; sedans normally come equipped with bumper jacks; pickups, panels, and carryalls normally have the screw-type jacks.

The VERTICAL SCREW JACK (view A, fig. 4-20) is operated by hand through a collapsible handle which is inserted in a socket. The screw moves up or down, depending on the direction



81.26
Figure 4-20.—Different types of jacks.

of rotation in which the handle is turned. Some of these jacks are equipped with a ratchet for automatic lowering. Mechanical screw jacks come in several capacities having different contracted and extended heights. Another type of screw jack is called an OUTRIGGER JACK (view A, fig. 4-20). It is equipped with end fittings which permit pulling parts together or pushing them apart.

A VERTICAL HYDRAULIC JACK (view B, fig. 4-20) operates through pressure applied to one side of a hydraulic cylinder which moves the jack head. Jacks of this type are automatically lowered or released by releasing the pressure. Vertical hydraulic jacks come in different capacities, ranging from 1/2 to 100 tons, and have different extended heights.

A PUSH-PULL HYDRAULIC JACK (view B, fig. 4-20) consists of a pump and ram connected by a hydraulic hose. Jacks of this type are available in 2-, 7-, 20-, 30-, or 100-ton capacity and have diversified applications.

The vertical jacks are used to lift one side or the end of a vehicle to permit removal of the wheel or tires or to effect repairs that would not be possible with the vehicle standing on its wheels. The jack can be used on each side alternately by jacking one side of the vehicle up, then blocking it and moving the jack to the other side, and then continuing this operation until the vehicle has been raised to the desired height.

Now let's go back to jacking up the vehicle in preparation for changing tires. It is probable that you may be doing this job without direct supervision. As a word of caution, make sure that you set the hand-brake, and that you block the vehicle to prevent it from rolling forward or backward before lifting it with a jack. If this is being done in the shop, ready-made chocks may be available for blocking purposes. If you are to change a rear wheel, place two chocks against each front wheel. If you are to change a front wheel, place two chocks against each rear wheel. If no chocks or blocks are readily available, any other object that will serve the same purpose may be used. The main thing is to have something that is sturdy enough to keep the vehicle from drifting forward or backward off the jack.

In changing a tire, the first consideration, however, is to have the spare tire ready and conveniently nearby. Some recommend that you lean it against the vehicle near the tire to be changed. Before doing this, check the tire to ensure that there are no nails, pieces of glass, or small stones embedded in the tread. If you find breaks in the fabric, loose liners, cuts and bruises, or other such defects, consult your supervisor. Any rust or rough surface on the rim should be removed to prevent tube irritation which may result in leaks. The procedure for removing from, and replacing a tire on, the rim will be explained later.

Now, with your spare tire ready—position the blocking. Position the jack in the appropriate place; if the ground is not firm, place the base of the jack on planking to spread the weight and prevent the jack from settling or slanting as it raises the load. After making sure that the jack is on firm footing, raise the vehicle slightly—leaving enough bearing pressure on the surface to prevent the wheel from turning when you start to loosen the lug nuts. Remove the hubcap or wheel cover and set it nearby at a convenient distance with the inside face up. Break the wheel lug nuts loose. You may find that, in older model vehicles, the wheels on the right side are fastened with right-hand threaded bolts, and those on the left side with left-hand threaded bolts, so as to offset the tendency to thread off as the wheels turn. The nut on the left-hand threaded bolt usually is stamped with the letter "L".

With the lug nuts loose, now raise the vehicle up with the jack until the tire is off the surface at a convenient working height. Then, remove the lug nuts and place them on the hubcap which you just removed. Lift the wheel and tire off the hub and set aside—a safe distance from your work. Get the spare tire and slide it slowly through the wheel bolts. Replace the lug nuts, making sure that they screw in without difficulty by just turning with your hand. Then use a wrench to barely tighten the lug nuts. It's better to tighten directly opposite lug nuts in turns to equalize pressure. Lower the vehicle gently to the surface by manipulating the jack. Give the final twists to the lug nuts; be sure that you exert just enough pressure to tighten these lug nuts to avoid damaging or stripping their threads. Replace the hubcap in the proper position and hammer it gently around, using a rubber mallet, until the hubcap is firmly set.

There may be occasions when you will have to remove a tire from the rim for repairs or replacement. Before removing the tire from the rim, check its external parts as explained above. Let the air out. Break the seal all around between the rim and the tire. Break the tire bead out all around one side using suitable tire equipment. If there is a tube, remove it carefully from the

tire. After the inner tube is removed, take the whole tire off the rim. Inspect the valve stem on the tube, or the valve stem on the wheel if it's a tubeless tire rim. If the valve stem on the wheel looks defective or deteriorated, it must be replaced before putting back the tire.

Inflate the tube until it is almost round. Then, inspect the tube for defects and test it for leaks. To test for leaks, immerse part of the inflated tube in a trough of water, then slowly turn the tube in a standing position until all around it has been through the water. If there is any leak, it will show in the form of air bubbles. As soon as a leak is discovered, circle it with a chalk marker. After all leaks are marked, let the air out and proceed to repair the holes. Two methods of repairing inner tubes are explained later in this discussion.

After the tube has been repaired, replace the rim on one side of the tire and insert the tube carefully all around the inside of the tire, making sure that the valve stem is lined up with the hole in the rim. Guide the valve stem through the valve hole. If it's a rubber stem, see that the stem enters the hole without bending. Put the other tire bead in, all the way around, using the tire iron. It may offer a little resistance, but guide it through with the tire iron. After all the beads are inside the rim, add air slowly and make sure that the tube is NOT pinched between the tire bead and the rim. The bead has to pop out all the way around the rim on both sides. Usually, you will hear a popping sound when this happens. You may use a rubber mallet (NOT a hammer) to strike the center of the tread around the tire to help seat the second bead and the tube properly.

In the case of a tubeless tire, a compressor band or a piece of flexible rope is tied around the tread of the tire to force the bead out and against the rim during inflation. For ease in slipping in the tire bead in the rim and in inflating, the outer edges of the bead that will come in contact with the rim are wetted all around with soap solution to lubricate the bead and create an instant seal all around the tire. Two methods of repairing tubeless tires are given later in this discussion.

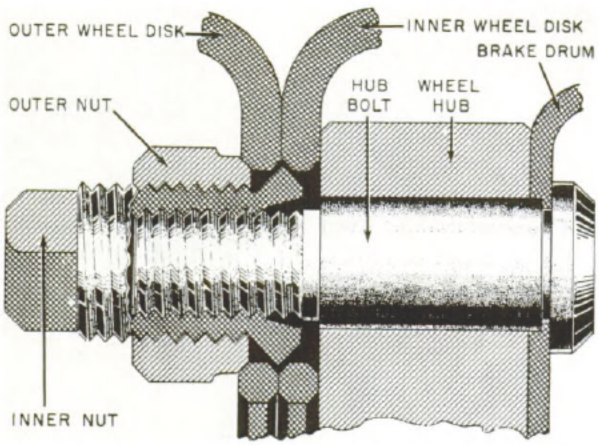
After mounting the tire on the rim, add the amount of air necessary to bring it up to required pressure. Make sure that you add the air slowly. As a safety measure, turn your face away from a tire when you are inflating it. (See fig. 4-21.) With the tire properly inflated, check closely to ensure that the tire beads fit snugly against the rim flanges. Tires, other than passenger car types, should always be inflated inside a safety cage.

As a further word on inflating tires, take care that you use the proper amount of air pressure. The inflation pressure depends on the size of tire and the purpose for which the automotive vehicle or equipment is used. Follow the recommended tire pressure given in the manufacturer's handbook for the particular automotive vehicle or construction equipment concerned, or consult your supervising petty officer.

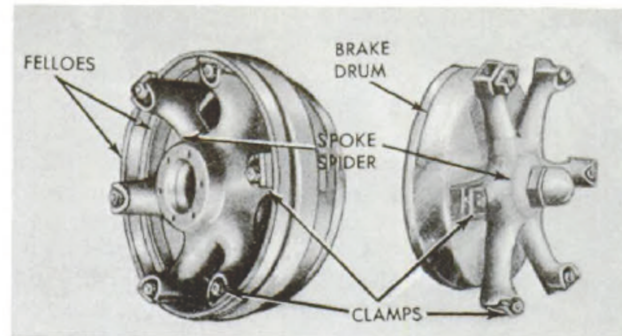
DUAL DISK WHEELS

Removing DUAL DISK WHEELS to change tires on heavy vehicles is not difficult if you understand how they are fastened. Generally, both disks are fastened together by two nuts on each hub bolt—one nut for each wheel. Either single or dual wheels can be securely mounted on the same hub with this arrangement. Outer nuts must be loosened first, freeing the outer wheel disk from the hub. Loosening the outer nuts, which thread over the inner nuts, unfastens the outer wheel disk. Sometimes, in removing dual disk wheels, you may find left-hand threads on both inner and outer nuts on the left wheels and right-hand threads on those of the right wheels. The dual disk wheel mounting is illustrated in figure 4-22. Reverse the procedure to mount and tighten the wheels.

29.110
Figure 4-21.—Turn face away from tire while inflating it.



29.111
Figure 4-22.—Dual disk wheel mounting.



29.112
Figure 4-23.—Truck spoke wheels.

SPOKE WHEELS

On trucks having SPOKE WHEELS (fig. 4-23), the tire and tube are removed with the rim. After removing the clamps which secure the rim on the wheel (spoke spider), the rim with the tire and tube can be lifted off. If the spoke wheel has two rims and tires, the second rim and tire can be lifted off after the spacer separating the rims is removed. In replacing the tires, the inner rim should be placed so that the valve stem can be reached easily for periodic inflation.

CHANGING TUBELESS TIRES

Most of the lighter Navy vehicles and many of the heavier vehicles now are equipped with tubeless tires. Instead of being sealed in an inner tube the air in these tires is sealed in the space between the outer casing and the rim. When using tire irons, care must be exercised not to tear or otherwise injure the sealing ribs around the beads.

Before replacing a tubeless tire, examine the rim carefully for dents, rough spots, and rust; any of these may weaken or break the air seal. Straighten out any dents with a hammer; use steel wool to clean the bead seat area of rust or grit. When a rim is badly bent or out-of-round, a new wheel must be provided.

The methods of removing and mounting tubeless tires are similar to the methods used for tubed tires. If the seal of a tubeless tire is broken or defective, you must use a tube inside the tire. Otherwise, the tire will lose air and you will have to inflate it frequently to bring it up to the required air pressure. If in doubt about other details of changing tubeless tires, follow the tire manufacturer's instructions, or consult your supervisory petty officer.

TUBE REPAIR

Hot and cold patches are used to repair punctures and small breaks or openings in tubes. You will find cold patching material, rubber cement, and the tools needed in a tube repair kit provided for repair purposes.

To apply a COLD patch, proceed as follows:

1. Buff or roughen the tube surface to be patched for at least 1 inch around the hole. Then clean the buffed area with solvent. If a buffer is not available, use the perforator cover of the kit as a scraper.

2. Apply a thin coating of rubber patching cement evenly over the roughened surface and allow it to dry 10 to 15 minutes.

3. Choose or cut a patch of the proper size (about three-fourths inch larger than the injury or opening) from the material in the kit. Round the corners of the patch. Remove the protective covering from the sticky side of the patch, place the patch over the hole, and press or roll it down firmly.

4. Inflate the tube with enough air to check for leaks. If you cannot hear or feel air escaping from the patch, you can make doubly sure that the tube does not leak by putting it in water. If no escaping air bubbles are present,

the tube may be dried and replaced in the tire or stored for future use.

HOT PATCHES are better than cold patches and should be used when available. They must be used to repair even small leaks and holes in synthetic rubber tubes. Each patching unit consists of a slow burning block of fuel held in a notched metal pan, on the bottom of which is a patch of uncured rubber. To apply a hot patch, follow the manufacturer's instructions on the kit.

Although methods of applying hot patches vary with the clamping devices provided and the shape of the patch, you will clean and roughen the tube just as you did in applying a cold patch. When the patching unit is clamped to the tube, the burning material is ignited, allowed to burn, and then cooled for at least 5 minutes. After this, examine the completed patch to see if the edges of the patching material are attached securely to the tube. Then replace the old valve core with a new one and test the tube. When used to repair leaks in natural rubber tubes, hot patches are more dependable than cold patches. Hot patches of assorted sizes are supplied in kits similar to the cold patch kits. In these, also, you will find pressure clamps and roughening tools.

REPAIRING TUBELESS TIRES

A main point to keep in mind is that a tubeless tire, in combination with the rim, must retain air. A tubeless tire has no tube or flap, and when punctured, air can escape. You can readily see, therefore, why a major purpose in every repair job is to RESEAL the tire to prevent the escape of air.

Various methods are used for repairing tubeless tires. Two common methods are (1) the plug method, for holes up to three-sixteenths of an inch in diameter; and (2) the gun method, for very small holes.

In the PLUG method, first clean out and repuncture the affected place on the tire. Then lightly buff the area inside the tire around the puncture for about 3 inches. Apply rubber cement to this area and to the rubber repair plug and allow it to dry. Now attach a wire needle, dipped in the cement, to the plug and push it through the hole from the inside of the tire. Pull the plug into place using a steady, continuous pull—avoid jerking! After the plug is firmly in place inside the tire, use a stitcher to remove air pockets. In trimming the plug, do not stretch it, or the repair will fail.

The GUN method does not require removal of the tire from the wheel, and it can be used without deflating the tire completely. Probe the hole with an awl or hand rasp furnished with the tire repair kit and remove any foreign matter. Be careful not to enlarge the hole. Then use the resealing gun, turning its screw three or four half-turns to fill the hole.

ROTATING TIRES

Rotating tires or changing them from one wheel to another so that they wear evenly is recommended by tire manufacturers. This must be done every 5,000 miles on Navy vehicles, or sooner if tires begin to show uneven wear. Rotate the tires on passenger vehicles in the following manner.

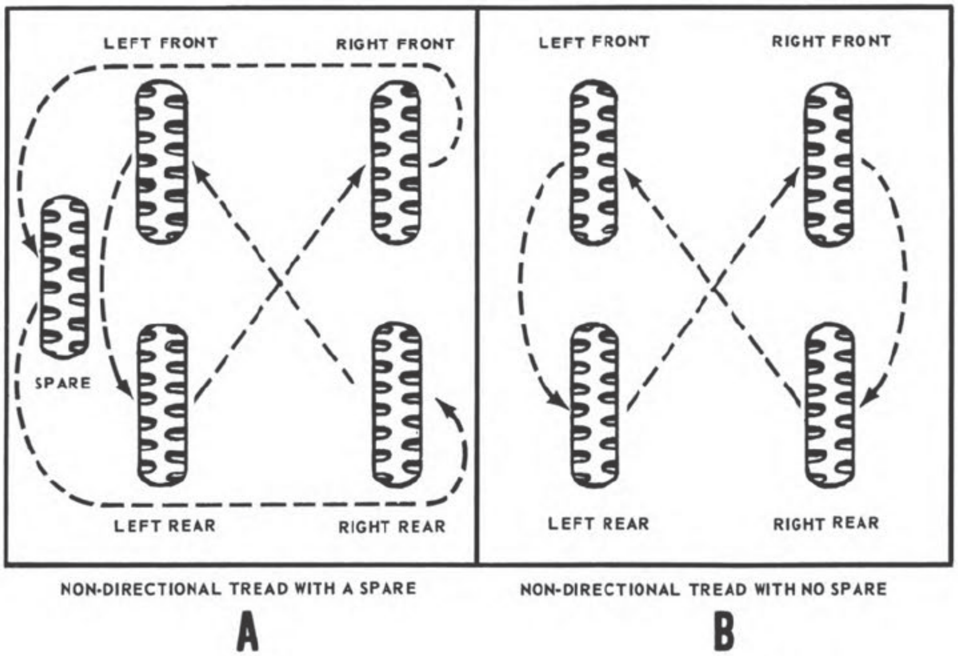
1. If the vehicle has a spare tire, the left front tire should be moved to the left rear, the right front to the spare, the two rears to the opposite front wheels, and the spare to the right rear. (See view A, fig. 4-24.)
2. If the vehicle has no spare, move the front tires to the rear on the same side, and move the rear to the opposite front wheels (view B, fig. 4-24).

In addition to the above methods, other rotation schemes also give good results. For instance, some manufacturers recommend moving the spare to the left front, the left front to the right rear, the right rear to the right front, the right front to the left rear, and the left rear to the spare.

ONCE A ROTATION SCHEME IS STARTED, THE SAME METHOD SHOULD ALWAYS BE USED.

STORAGE OF TIRES AND TUBES

Tires and tubes can be preserved a considerable period of time if proper precautions are carefully observed in their storage and care. An ideal place of storage for tires and tubes is a place inside that is dry, dark, and cool. It is also important that the place of storage provide protection against oils, greases, dust, moisture, and the like. A point to keep uppermost in mind is that whether tires and tubes are stored for a short period or a long period of time, the same precautions must be observed



29.113
Figure 4-24.—Recommended tire and wheel rotation.

to ensure adequate protection against deterioration. Let us take a look at some of the other major factors to consider in the storage of new tires, old tires, and inner tubes—in that order.

New Tires

At some activities, inside storage of tires is not possible, in which case outdoor storage must be used. One of the main precautions to take, where outdoor storage is necessary, is to cover the tires with a tarpaulin or other heavy, tightly woven fabric (fig. 4-25). This type of covering will help a lot in protecting the tires against such destructive elements as light, air, rain, and dirt. Another important precaution is to keep tires off the ground.

When storing tires inside, avoid piling them near radiators or other sources of heat. Since high temperatures tend to increase the rate of deterioration, keep the temperature in the storage room low. It has been found that temperatures between 32° F and 80° F are preferable.

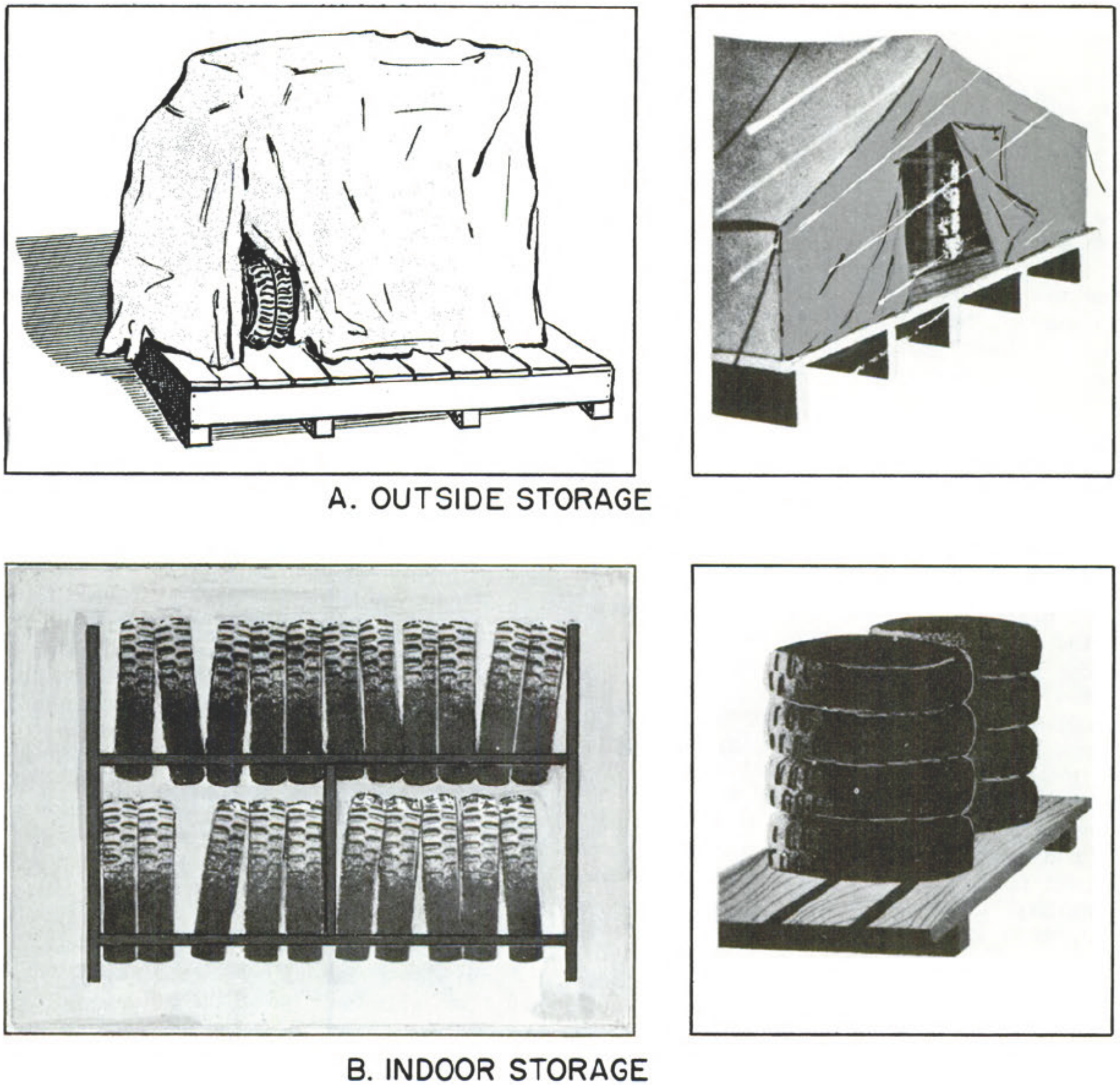
If possible, place the tires in an area where they will not be exposed to light from windows or skylights; it is a good idea that glass in such openings be painted over with dark paint. All doors and other such openings should be kept covered or closed. Insofar as possible, avoid drafts and other movement of air and keep the storage room free from moisture.

Do not store tires in a room where electrical discharges occur as a result of the operation of electric motors, generators, switches, or other electrical devices. These discharges generate ozone which greatly accelerates the process of oxidation, thus increasing the rate of deterioration.

Never stack tires on a dirty floor. As a safeguard, first lay a foundation of clean wood strips 1/2 to 3/4 inch thick. If pallets are available and space warrants, use pallets instead of strips of wood.

The tires may be piled horizontally one on top of the other, or placed on shelves side by side (fig. 4-25). Naturally, tires stored on shelves (side by side) are grouped according to sizes for easy identification and control. If tires are stacked, you must limit the height of the pile in order to avoid distortion of the tires on the bottom.

If possible, avoid stacking two or more sizes of tires in the same pile. This may be necessary under certain conditions, such as a shortage of space. Under no circumstance, however, should you pile tires of a larger size and



29.114.1
Figure 4-25.—Tire storage.

greater weight upon smaller tires. (Another practice to avoid is that of "lacing" (or staggering) the tires in a pile. This practice tends to kink the bead wires and distort the form of the tire.

Old Tires

In general, the same precautions that apply to the storage of new tires also apply to the storage of old tires. Here are several additional precautions, though, which should be observed.

For one thing, clean old tires thoroughly and check them closely for possible defects. If repairs are necessary, make them before placing the tire in storage.

Cover all exposed cord with rubber repair materials. This is important because the fabric

without a sealed protective covering absorbs moisture.

Sometimes vehicles are placed in storage and the tires remain mounted on the equipment. In such cases, you can block up the equipment to keep its weight from resting on the tires. Also, the air pressure in such tires should be maintained between one-third and two-thirds normal operating pressure. If it is not possible to block up the equipment, the air pressure in the tires must be checked at frequent intervals.

If outside storage is necessary, it is good practice to apply a coating of tire preservative after cleaning the tires. Use of a cover or wrapping of heavy canvas or similar material also is recommended.

Tubes

New tubes that are to be stored should not be inflated. Store them so that weight will not cause stretching along the folds. Leave new tubes in their original package. If not boxed, tubes should be stored in a clean, cool place where they are well covered and protected from the same sources of damage as described for new tires.

In some instances, tires are received with the tubes already mounted inside and removal of the tubes is not required. Before storage, however, reduce the air pressure to the lowest point necessary to retain the tube in the tire.

When used tubes are to go into storage, remove them from the tires and deflate completely by removing the valve core. Then fold the tubes carefully and store them in the same manner as new tubes. In case repairs are needed, it is recommended that they be made before storage.

SAFETY IN THE GARAGE

Too strong emphasis cannot be placed on the need for practicing safety when working in or around the garage. In preceding sections, safety precautions applicable to specific duties or equipment were pointed out. A few additional precautions, applicable to safety in general, are presented below.

The shop or garage should be kept clean and free of tripping hazards. There should be a place for storage of tools, air and water hoses, jacks, water cans, and so forth. Each should be kept in its proper place when not in use.

Floors and other exposed surfaces should be maintained in clean condition. Exercise care to prevent hazards on floors, such as oil, grease, or loose tools which might result in fire, slipping, tripping, or falling.

Wear protective apparel—such as goggles, rubber gloves, aprons, safety shoes, and special gloves—on jobs where required for personal protection. Do not wear rings when servicing batteries or working on motor vehicles.

Garages and repair shops should be well ventilated for protection against carbon monoxide gas from running engines. (If the shop cannot be sufficiently ventilated to ensure maximum safety, a vehicle should be driven outside as soon as its engine has been started.)

Adequate illumination should be provided and utilized for all general work areas—including work benches, lubrication pits, and other work locations.

As a reminder, learn where all fire extinguishers in the shop are located and how to use them.

Your shop will have a list of safety regulations posted. Study these regulations until you are thoroughly familiar with them.

CHAPTER 5

SURVEYING, DRAFTING, AND QUALITY CONTROL

Surveying, drafting, and quality control are principal duties of the Engineering Aid (EA). Surveying is primarily fieldwork and drafting primarily officework. Quality control is carried on in the field, laboratory and office. All three areas, however, usually overlap one another to some extent. For example, most notes compiled from surveys are computed and plotted (drawn to scale) in the office. Conversely, several construction surveys result from designs or drawings prepared in the engineering/drafting office. Much quality control work consists of material samples taken in the field, tested in a laboratory, and analyzed in the office.

This chapter will give you an overview of the various duties of the Engineering Aid; the equipment used by him in surveying, drafting, and quality control; and the various duties that you, as a Constructionman, may perform if you are assigned to work with these men.

SURVEYING

Basically, the principal surveying duties of an Engineering Aid deal with the determination of the horizontal and vertical location of points. The relative positions of these points are necessary in construction for locating or laying out the outlines of buildings and similar structures, the centerlines of roads and airfields, and those points that may be needed for control of cultural, hydrographic, or terrain features for mapping purposes. In military operations, these points may become targets for artillery.

In addition, the surveyor may be required to collect engineering data for the planning and design of structures. He may be required to measure work-in-place quantities for progress control or reports. He may also measure finished structures to get existing dimensions for as-built drawings.

TYPES OF SURVEYS

Surveying is divided into two major categories: plane surveying and geodetic surveying. PLANE SURVEYING is the term used to designate surveys which involve distances and areas that are small enough to be measured without any significant error resulting from the effect created by the curvature of the earth. In this category, the portion of the earth being surveyed is considered as lying in a plane surface. Most surveys made for construction projects are classified as "plane surveys."

In GEODETIC SURVEYING, the curvature of the earth is taken into account. Large area surveys for geographical mapping purposes are usually geodetic surveys. Geodetic surveying is seldom performed by SEABEES.

Generally the name given to a particular survey is derived from the application or purpose of the survey. Descriptions and applications of the typical types of surveys are given below.

Land Surveys

A survey made to establish the exact location, boundaries, or subdivision of a tract of land in any specified area is called a LAND SURVEY. When this work is primarily done within the city limits, it is referred to as CITY SURVEYING. Some purposes of land surveys are:

1. To establish markers or monuments to define and thereby preserve the boundaries of land belonging to a private concern, corporation, or the government.

2. To relocate markers or monuments legally established by original surveys. This requires examining previous survey records and retracing what was done. When some markers or monuments are missing, they are re-established in accordance with recognized procedures, using whatever information is available.

3. To calculate areas, distances and directions and prepare a land map to portray the survey data so that it can be used as a permanent record.

Topographic Surveys

The purpose of a TOPOGRAPHIC SURVEY is to gather survey data about the natural and man-made features of the land as well as its elevations, from which a three-dimensional map may be prepared. The topographic map may be prepared in the office after collecting the field data, or done right away in the field by plane-table and alidade (described later).

Construction Surveys

A CONSTRUCTION SURVEY (also called ENGINEERING SURVEY) is the orderly process of obtaining data for the various phases of construction activity. It includes the RECONNAISSANCE SURVEY, the PRELIMINARY SURVEY, the LOCATION SURVEY, the LAYOUT SURVEY, and the AS-BUILT SURVEY. Some objectives of construction surveying include:

1. Obtaining reconnaissance information and preliminary data required by engineers for selecting suitable routes and sites, and for preparing structural designs.
2. Defining selected locations by establishing a system of reference points.
3. Guidance of construction forces by setting stakes or otherwise marking lines, grades, and principal points, and by giving technical assistance.
4. The measuring of construction items in place for the purpose of preparing progress reports.
5. The dimensioning of structures for the preparation of as-built drawings. AS-BUILT drawings show the structure as it was actually constructed and it may be somewhat different from the original design.

Construction and/or engineering surveys, then, form part of a series of activities leading to the construction of a man-made structure. The term STRUCTURE is usually confined to something which is built of structural members, such as a building or a bridge. It is used here in a broader sense, however, to include all man-made features, such as graded areas; sewerlines, powerlines, and waterlines; roads and highways; and waterfront structures.

Route Surveys

The term ROUTE SURVEY refers to surveys necessary for the location and construction of lines of transportation or communication which continue across country for some distance, such as highways, railroads, open conduit systems, pipelines and powerlines. Generally, the preliminary survey for this work takes the form of a topographic survey.

Underground Surveys

Underground surveys are employed in mining, tunneling, and the construction of underground structures such as missile silos, power stations, shopping center complexes, and so on. The survey methods used in one of these types of works can be applied to the others, so that, if the EA can perform one, he can do the rest of them.

Photogrammetric Surveys

A survey that utilizes either ground or aerial photographs to collect data for mapping purposes is called a PHOTOGRAMMETRIC SURVEY. Photogrammetric surveys are classified as either CONTROLLED or UNCONTROLLED. Controlled photogrammetric surveys require field surveys to coordinate and correlate aerial photographic data with ground data, while uncontrolled photogrammetric surveys generally cover comparatively large areas; therefore, the relative positions of control stations are determined by geodetic survey procedures.

Hydrographic Surveys

A HYDROGRAPHIC SURVEY is one which has for its principal purpose the determination of data necessary to chart the shorelines of bodies of water, as well as the determination of the shape of the area underlying the water's surface.

SURVEY PARTIES

The size of a field survey party depends upon the survey requirements, the equipment available, the method of survey, and the number of personnel needed to perform the different survey

functions. The name given to a particular survey party is generally derived from the type of instrument used or from the purpose of the survey. For example, a field party which is determining horizontal locations of points, or establishing points at given horizontal locations, is a "transit" party, so-called because it uses a transit (described later) for determining horizontal directions. A transit party consists of a party chief (also called chief-of-party and not to be confused with a Chief Petty Officer), an instrumentman, a notekeeper, a head chainman, and a rear chainman. The party chief and instrumentman may be one and the same, and it may be the case that the same individual acts as party chief, instrumentman, and notekeeper. If the party is running line through rough country, there may be one or more axmen assigned to clearing growth ahead of the party, or one or both of the chainmen may serve as axmen.

A field party which is engaged in the process of determining elevations is called a level party, because its principal instrument is the engineer's level (described later). A level party consists of a party chief, instrumentman, notekeeper, and one or two rodmen. Again the party chief may double as instrumentman, or as both instrumentman and notekeeper.

A Constructionman may serve as chainman in a transit party or as rodman in a level party.

SURVEYING INSTRUMENTS

The following descriptions of the principal surveying instruments are intended only to give you a general idea of their appearances and uses.

Engineer's Level

An ENGINEER'S LEVEL is a tripod-mounted optical instrument which, when it is set up and carefully leveled, provides a precise level line-of-sight in any direction. There are several types of engineer's levels; however, the ones you will see most frequently are the DUMPY LEVEL, WYE-LEVEL, PRECISE TILTING LEVEL, and SELF-LEVELING LEVEL.

Basically, all engineer's levels consist of a TELESCOPE supported by an adjustable LEVELING HEAD, which is in turn supported by a FOOTPLATE screwed to the HEAD (top) of the tripod. The instruments are leveled by manipulating LEVELING SCREWS until the LEVEL VIAL under the telescope reads level in any direction.

The instrumentman is aided by vertical and horizontal CROSSHAIRS which can be focused on a TARGET. To a surveyor, a target is any object upon which the instrument is trained; however, it is usually a level rod (described later).

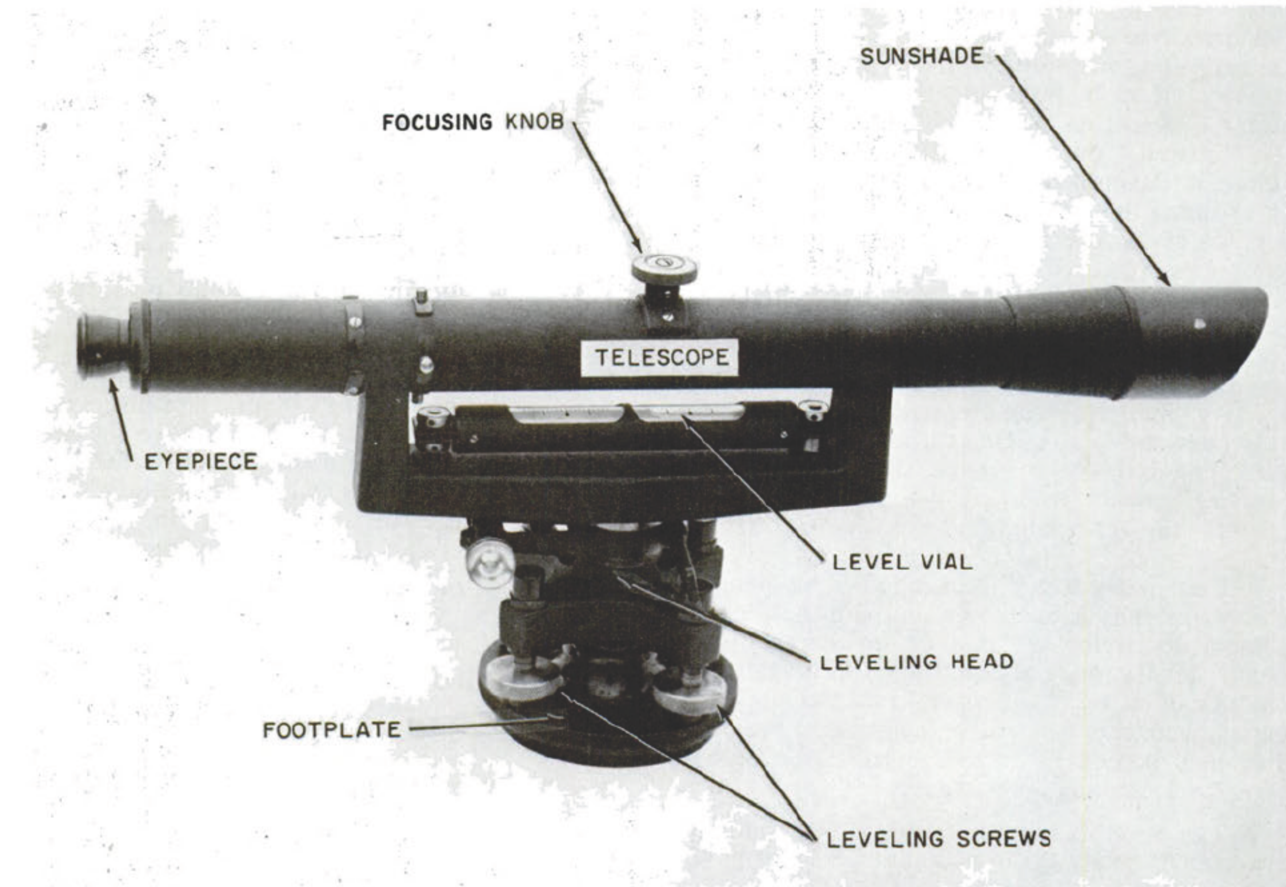
The instrument most commonly used in work of ordinary precision is the DUMPY LEVEL shown in figure 5-1. The WYE LEVEL (fig. 5-2) is named for the shape of its telescope supports which may be opened at the top in order to rotate or reverse the telescope. Wye levels are less reliable than the dumpy level because there are many more parts, which frequently get out of adjustment. For this reason they are systematically being replaced.

The PRECISE TILTING LEVEL is so named because it has an extra control for "fine leveling." This control is usually located under the eyepiece of the telescope. Tilting levels are very precise instruments; however, they are seldom used by SEABEES.

Older type levels are rapidly being replaced by the SELF-LEVELING LEVEL. The telescope of this type of level contains a pendulum-type prism called a COMPENSATOR. Regardless of slight out-of-sight conditions, the compensator maintains a constantly level line-of-sight. Figure 5-3 illustrates a self-leveling level and its principle of operation. The advantages of this type of instrument over others are found in the time saved in setting up and in the ease in reading.

Various TRIPODS are used by surveyors. Some are shown in figure 5-4. Note that one type has adjustable legs for use in especially rough terrain.

The engineer's level is used most frequently to determine elevations in the field or for locating points at specified elevations. The procedure used is known as DIFFERENTIAL LEVELING. This procedure, as the name implies, is nothing more than finding the vertical DIFFERENCE between a known (or assumed) elevation (called a REFERENCE) and the point in question. Once this difference is measured, it can be added to, or subtracted from (depending on the circumstances) the known elevation of the reference to determine the elevation of the new point. For

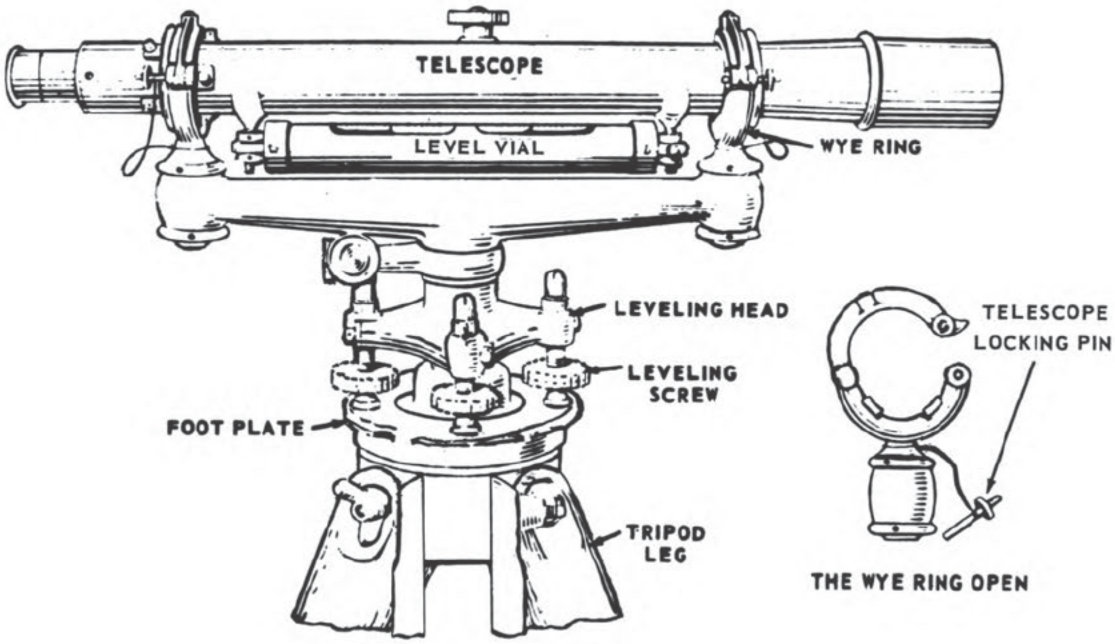


29.245A
Figure 5-1.—Dumpy level.

example, in figure 5-5, we are concerned with finding the height of point B. Point A (the reference) is given as 365.01 ft. probably above sea level. If the level was setup where indicated and the instrumentman obtained a reading there of 11.56 ft, we would know that the level line of sight is 11.56 ft higher than Point A. We would then add this figure (11.56) to our original elevation (365.01) and get a new elevation of 376.57 ft. This new elevation is known as the HEIGHT OF INSTRUMENT (H.I.) and from this we can determine any other elevation within reading distance of the level. Sighting on Point B, the instrumentman next gets a reading of 1.42 ft. Knowing that this point is below the line of sight (otherwise he couldn't see it), he would subtract 1.42 ft from the H.I. and get a new elevation of 375.15. This is the elevation of Point B.

The Transit

The TRANSIT (fig. 5-6), often called ENGINEER'S or SURVEYOR'S TRANSIT, is similar to the engineer's level in many respects. The principal difference is in its use in measuring horizontal and vertical angles, whereas the level can only be used in leveling and no angular measurements can be made. To do this, the transit is equipped with a leveling head containing an UPPER and LOWER PLATE, which allows the upper portion of the instrument to rotate a full 360 degrees horizontally. Another significant feature is the HORIZONTAL AXIS which permits the telescope to rotate vertically, usually a full 360 degrees on newer instruments. Transits can be used for differential leveling, although levels are preferred for more precision work.



29.244
Figure 5-2.—Wye level.

Figures 5-7 and 5-8 illustrate the two basic uses of the transit in angular measurement. In figure 5-7, the instrumentman is concerned with finding the location of Point C, which lies across a river and cannot be measured by using a steel tape. By establishing a base line (AB), which can be measured accurately, and reading angles at A from B to C (35°06') and at B from A to C (48°15'), the Engineering Aid can compute the exact location of C by applying certain mathematical formulas which relate only to triangles. You are not required to be able to make these computations; however, if you were given the distance AB and the two angles, you could locate C approximately with graph paper and a protractor. In figure 5-8, we apply the same principles to finding the height of a flagpole. By measuring the distance AB and the angle between B and C the EA is able to compute the vertical distance BC. Of course, the distance BD must be measured and added to the result.

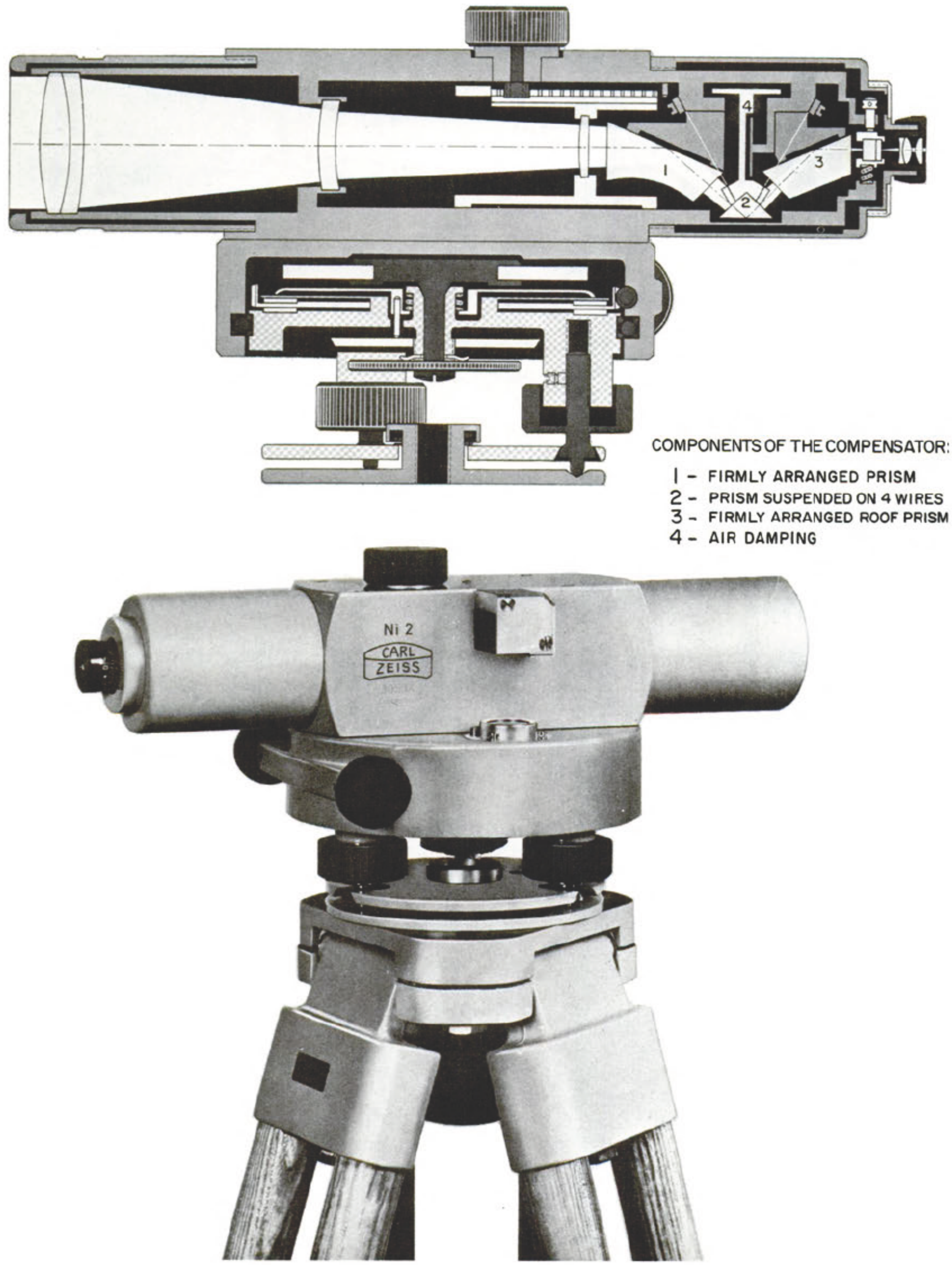
Hand Levels

There are two types of HAND LEVELS: the Locke level (fig. 5-9) and the Abney level (fig. 5-10). Both are used for the rough determination of a number of elevations from a point of known elevation. The instrument is held to the eye and a level line of sight is obtained by bringing the reflection of a bubble in the spirit level into alignment with a horizontal marker at the end of the telescope.

In addition to getting a rough level line of sight, the Abney level can also be used to roughly measure vertical angles. For example, in figure 5-11 we might be concerned with finding the height of the tree so that we could estimate how much lumber could be cut from it. It wouldn't be necessary to compute this down to the closest fraction of an inch or even foot.

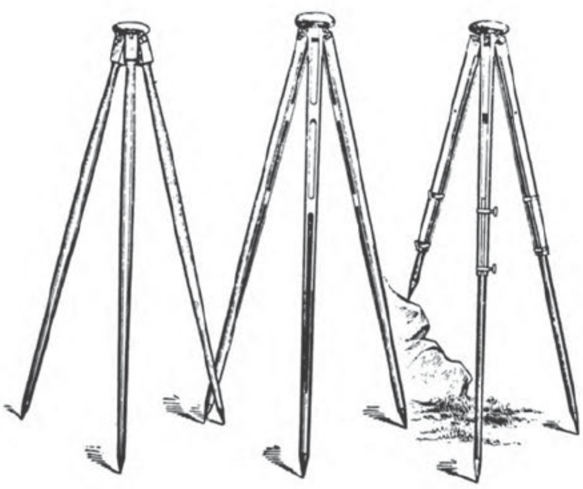
Magnetic Compasses

There are many types of MAGNETIC COMPASSES used by surveyors. The most common type is the POCKET COMPASS (fig. 5-12) which, in appearance, is similar to a pocket watch. Magnetic compasses have two principal parts: A COMPASS CARD, which is usually graduated in degrees, and a magnetic NEEDLE located in the center of the card. The needle is free to rotate and, when free from local attractions (such as a rifle or helmet), it lines itself up with the local magnetic North-South direction,



45,750X

Figure 5-3. —Self-leveling level.



29.243AX
Figure 5-4.—Types of tripods.

due to the attraction of the earth's magnetic North Pole.

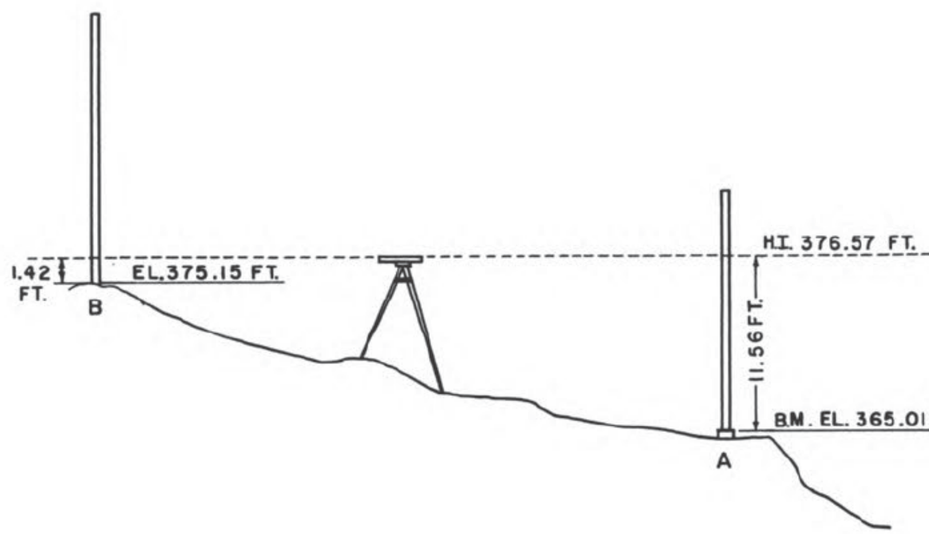
Compasses are principally used in running lines or determining direction of survey lines which require work of less precision. They are suitable for use in rough surveys and in reconnaissance surveys for highways and similar projects. The uses of compasses and maps are covered more thoroughly in the SEABEE Combat Handbook.

Other magnetic compasses have special features for use by surveyors. One of these, a modern SURVEYING COMPASS, is shown in figure 5-13. Note the SIGHTING VANES which aid the user in "aimming."

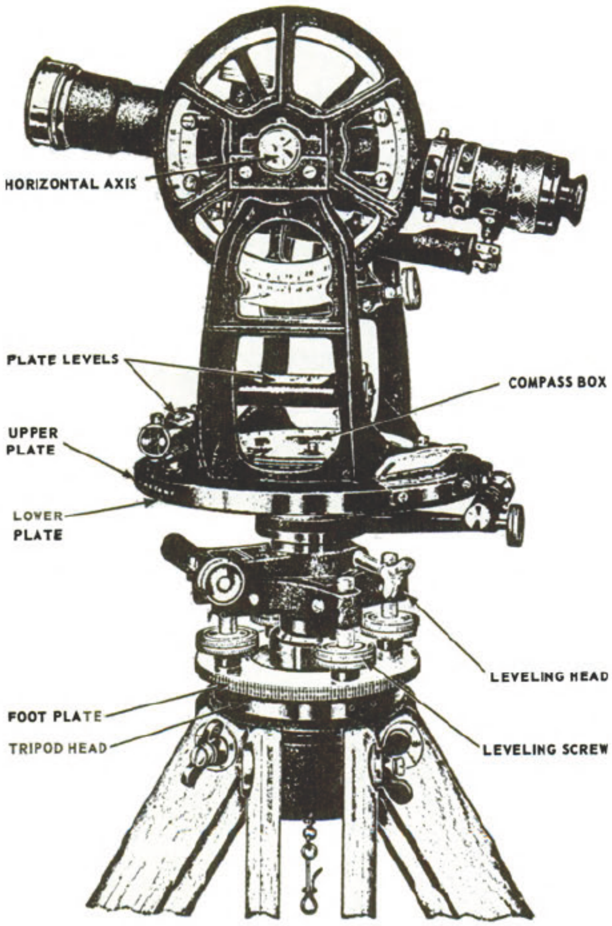
Planetable and Alidade

The PLANETABLE and ALIDADE (fig. 5-14) are used for the direct measurement and plotting of angles in the field. The alidade is an optical instrument very similar to the transit. When in use, it is placed on a sheet of paper mounted on the planetable. A rectangular metal straightedge, called a BLADE, is mounted to the base of the instrument. The blade keeps the instrument steady and the long right-hand edge, which is parallel to the line-of-sight, is used in drawing the angular lines.

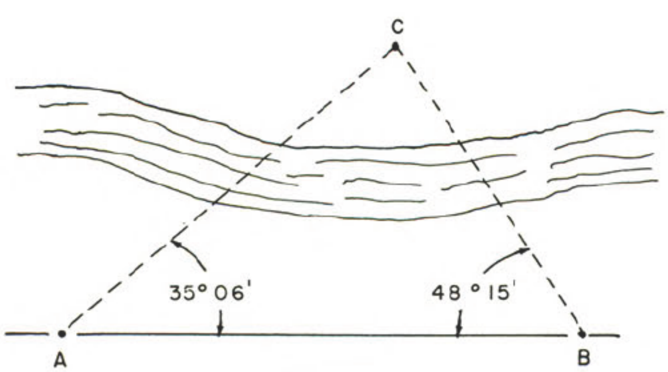
The planetable consists of a drawing board mounted on the head of a tripod. The board is leveled by manipulating screws on a leveling head and by using the spirit level on the blade of the alidade. Some planetables have built-in spirit levels.



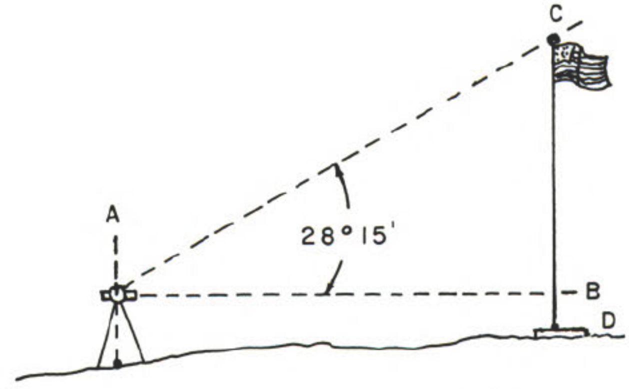
45.31
Figure 5-5.—Procedure for differential leveling.



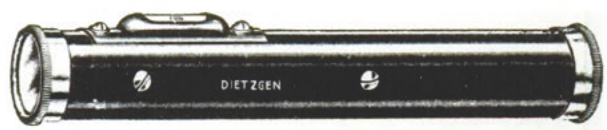
29.242
Figure 5-6.—Surveyor's transit.



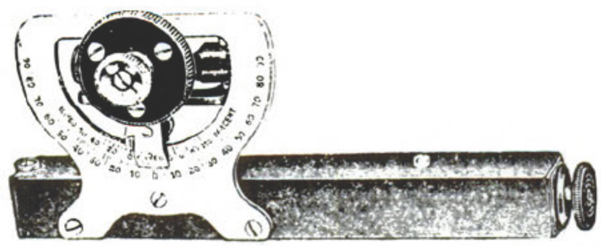
45.51(29E)
Figure 5-7.—Finding an unknown horizontal distance.



45.10(29E)
Figure 5-8.—Finding an unknown vertical distance.



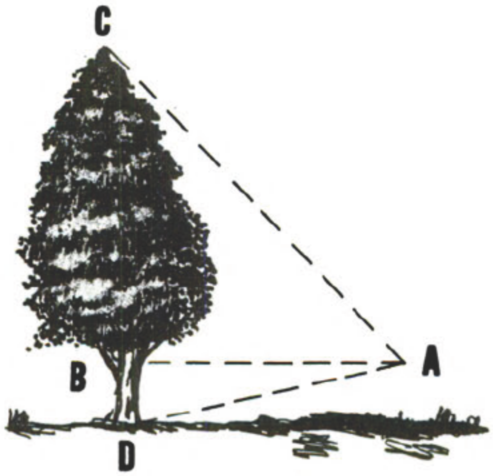
29.246X
Figure 5-9.—Locke level.



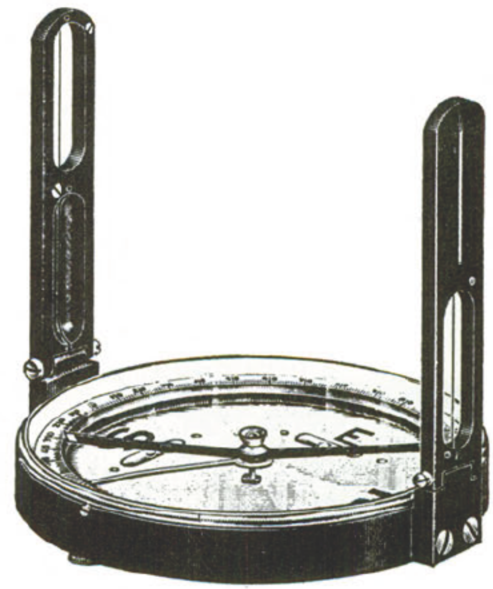
29.247X
Figure 5-10.—Abney level.

HORIZONTAL CONTROL

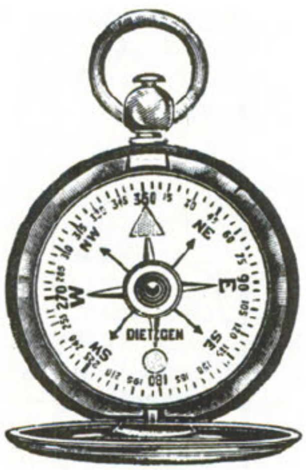
The surveying of a construction project usually begins with the establishment of a framework or pattern of points of known horizontal location along or over the construction site. This procedure is called the establishment of HORIZONTAL CONTROL, and the points so established are called CONTROL POINTS, from each of which the locations of any other required points in the vicinity can be determined. Horizontal



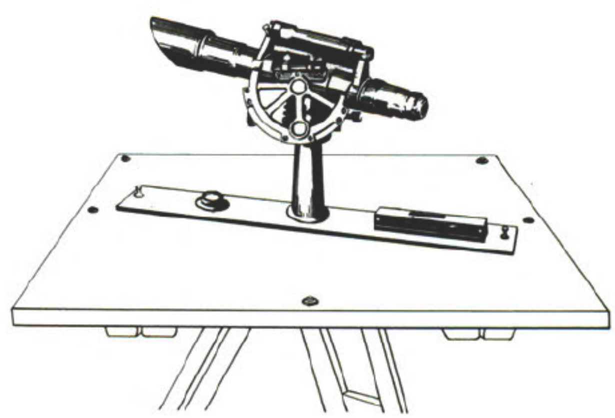
29.404
Figure 5-11.—Finding rough vertical measurements with the Abney level.



45.26X
Figure 5-13.—A modern surveyor's compass.



45.22X
Figure 5-12.—Pocket compass.



45.39
Figure 5-14.—Planetable and alidade.

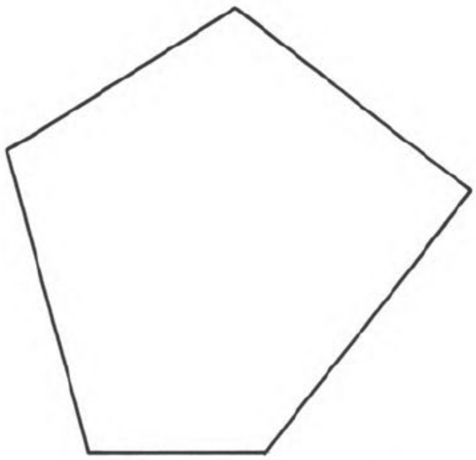
control may be established by TRAVERSING or by TRIANGULATION.

Traversing

TRAVERSING begins at a point of known location, from which the location of each successive point is determined by determining the DIRECTION (in degrees) and the DISTANCE (in some type of linear measurement). The succession of lines from point to point is called a TRAVERSE and each line between points is called a TRAVERSE LINE.

A traverse which returns to the point from which it started (such as a property boundary traverse) is called a CLOSED TRAVERSE (fig. 5-15). One which does not (such as a highway centerline traverse) is called an OPEN TRAVERSE (fig. 5-16).

A point where two or more traverse lines intersect one another is called a traverse station. The term STATION has several meanings in



45.4
Figure 5-15.—Closed traverse.

45.5
Figure 5-16.—Open traverse.

surveying. However, in general, station refers to a point of some significance, which is located by horizontal and/or vertical measurements. Stations are further defined by the character of the survey, the nature of the point, or the intended use of the station. Stations are usually assigned code names, numbers or letters for easy identification and reference.

Triangulation

In TRIANGULATION the starting basis for the location of points is a BASE LINE of very carefully determined direction and very carefully measured length. To determine the location of any third point with respect to the two end points of a base line, it is only necessary to measure (with transit) the angles between the ends of the base line and the lines from these ends to the third point. If you remember, this is exactly the procedure we explained for locating Point (station) C in figure 5-7. Triangulation is used when long distances, offshore points, or other circumstances make conventional measuring unfeasible or impossible.

Field Supplies and Equipment

FIELD SUPPLIES consist of a variety of materials used to mark survey points established or located in the field. These are materials such as stakes, hubs, and keel (lumber crayons). These supplies are generally made of consumable materials—that is, materials which, once they are used, are not recoverable for reuse.

In ordinary soil, a point may be marked by driving a wooden STAKE or a wooden HUB. A stake extends a foot or two above the ground so that information (such as the station number) can be printed on the side. Stakes are generally made of 1'' x 2'' material. A hub is a square-section marker (usually 2'' x 2'' x 8'') which is driven nearly flush with the ground and at a point of significance, such as the intersecting traverse lines which we discussed above. A tack is driven into the top of the hub to indicate the exact point the hub is marking.

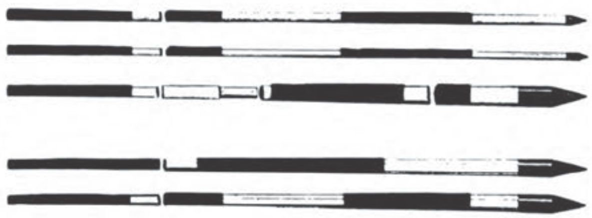
To make stakes more easily observable, a short length of colored plastic or cloth ribbon, called FLAGGING, may be attached to the top.

Waterproof lumber crayon, called KEEL by surveyors, is used to inscribe information on stakes and also to mark points or information temporarily on hard surfaces, such as asphalt or concrete.

The term FIELD EQUIPMENT refers, in general, to tools or devices (other than the instruments) which are reused indefinitely or until they are worn out. Equipment in this category includes such items as range poles, chaining pins, plumb bobs, sledge hammer, various brush clearing tools, and the like. Tapes, used for measuring distances, are discussed separately below.

Figure 5-17 shows a variety of RANGE POLES. A range pole is a wood or metal pole, usually about 8 ft long and about 1/2 to 1 in. in diameter, pointed at the lower end and painted in alternate bands of red and white to increase visibility. A range pole is held vertically on a point or plumbed over a point so that the point may be observed through an optical instrument.

A PLUMB BOB is a pointed, tapered brass or bronze weight which is used, suspended from a cord, for the general purpose of determining the plumb line from a point on the ground. It is a precision tool and it must be cared for as such. If the tip becomes bent, the cord will not occupy the true plumb line over the point indicated by the tip.



29.257X
Figure 5-17.—Range poles.

The cord from a plumb can be made more conspicuous, for observation purposes, by attaching a red and white target as shown in figure 5-18.

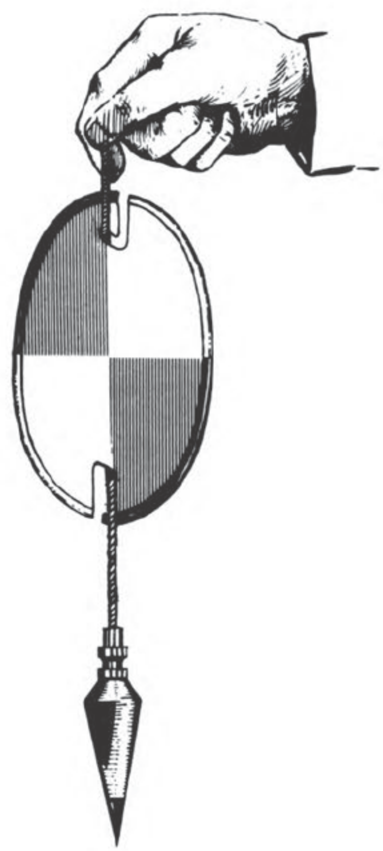
A CHAINING PIN is a metal pin about a foot long which has a circular eye at one end and a point (for thrusting in the ground) at the other (fig. 5-19). Chaining pins can be used for the temporary marking of points in a great variety of situations, but they are used most frequently to keep count of tape increments in the "chaining" (measuring) of long distances.

Surveying procedures usually permit the bypassing of large trees. Occasionally, however, it may be necessary to fell a tree. Procedures for felling trees are covered in chapter 6 of this manual.

Brush and other natural growth are commonly cleared from the line-of-sight with the tools shown in figure 5-20. The machete and brush hook are used for clearing small saplings, bushes, vines, and similar growth. Axes and hatchets are used for felling trees and also for "blazing" (marking) by trimming off an area of bark.

Chaining/Taping Equipment

The term CHAINING means the measurement of linear distance by tape or chain. Real chains (those made with links) are seldom used by modern surveyors; however, the term CHAIN is still used and it is understood by surveyors to mean tape or chain. Tapes are used in surveying to measure horizontal, slope, and vertical distances. They are made of a ribbon or band of steel, alloys of steel, cloth reinforced with metal, and various synthetic materials. Tapes are issued in several lengths and widths and are graduated in a variety of ways. A few of the more common tapes are discussed below.

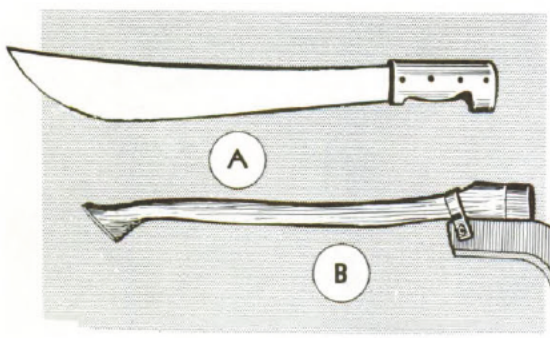


29.258
Figure 5-18.—Plumb bob with line and target.

WOVEN TAPES.—There are two types of woven tapes. These are the NON-METALLIC WOVEN TAPE and the METALLIC WOVEN TAPE. Non-metallic woven tapes are usually made of high-grade cloth (usually linen) fabric. Some newer types are woven from synthetic yarn (such as nylon) and are coated with plastic. Metallic woven tapes consist of cloth fabric reinforced with fine bronze or brass wire strands.

Woven tapes are made in 25-, 50-, 75-, 100-, and 150-ft lengths. Some are graduated in feet and inches to the nearest 1/4 in. Others are graduated in feet and decimals of a foot to the nearest 0.05 ft, such as the one illustrated in figure 5-21. It should be noted that although the tape is graduated to the nearest 0.05-ft intervals, only the 0.10-ft intervals are numbered. In point of fact, a woven tape is not usually used for work of higher precision than that calling for measurements to the nearest 0.1-ft. Therefore,

29.255X
Figure 5-19.—Chaining pins.

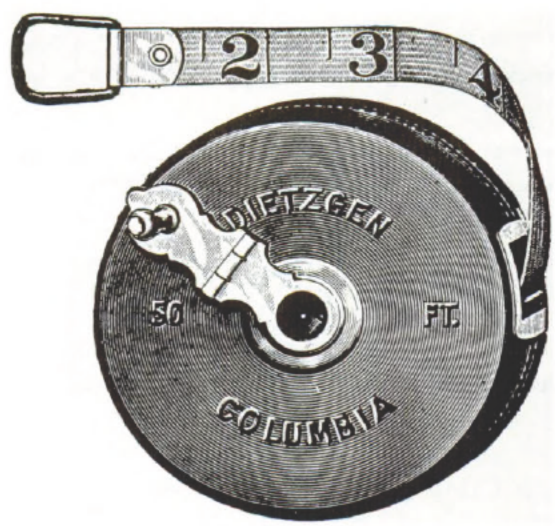


29.250X
Figure 5-20.—(A) Machete. (B) Brush hook.

these tapes are usually read to the nearest 0.1-ft and the 0.05-ft graduation serves only to indicate which of the adjacent 0.1-ft graduations is nearest.

STEEL TAPES.—For direct linear measurements of ordinary precision or higher a steel tape is required. The most commonly used length is 100-ft, but tapes are also available in 50-, 200-, 300-, and 500-ft lengths. All but the 500-ft tape are band types, usually 1/4 to 5/16 in. wide. The 500-ft tape is usually a wire tape.

Some tapes, such as the ENGINEER'S TAPE, are graduated throughout in subdivisions of each foot. The tape most commonly used, however, is the so called CHAIN TAPE, on which only the first foot at the zero end of the tape is graduated in subdivisions. The main body of the tape is only graduated at every 1-ft mark.



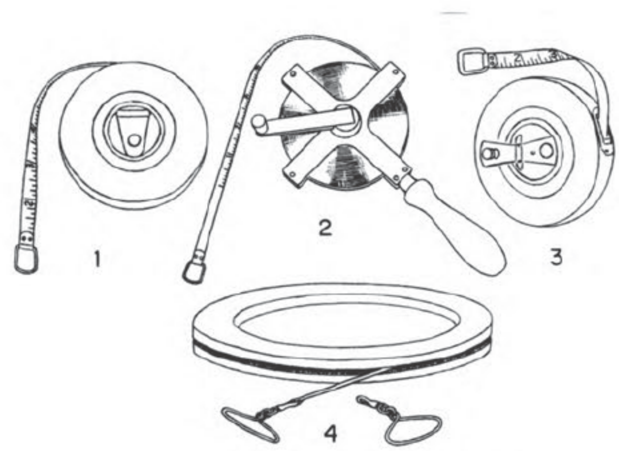
45.628X
Figure 5-21.—Woven tape.

A chain tape may be either a "plus" (or "add") tape or a "minus" (or "subtract") tape. On a plus tape the end-foot, graduated in subdivisions, is an extra foot, lying outside the 0-ft mark on the tape, and graduated AWAY from the 0-ft mark. On a minus tape the end-foot, graduated in subdivisions, is the foot lying between the 0-ft mark and the 1-ft mark, and it is graduated from the 0-ft mark toward the 1-ft mark.

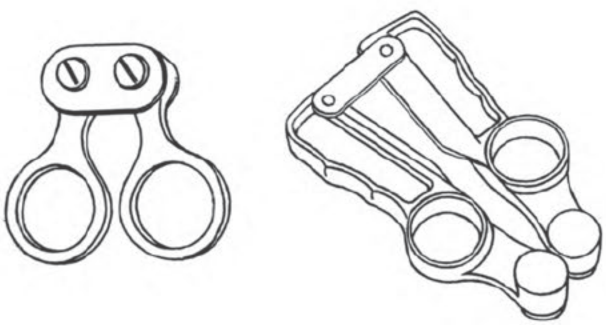
A steel tape is sometimes equipped with a reel, on which the tape can be wound. A tape can be, and often is, detached from the reel, however, for more convenient use in taping.

Various types of surveying tapes are shown in figure 5-22. No. 1 is a metallic tape. No. 2 is a steel tape on an open reel. No. 3 is a steel tape on a closed reel. No. 4 is a special type of low-expansion steel tape used in high-order work. It is kept on the large reel shown to minimize bending distortion.

TAPING ACCESSORIES.—There is usually a leather thong at the end (or at each end of some types) of a steel tape which is used to hold the end securely. When only part of the tape is to be used, the zero end is held with the thong and the tape is grasped at an intermediate point with a CLAMP HANDLE like those shown in figure 5-23.



45.629X
Figure 5-22.—Surveying tapes.



45.662X
Figure 5-23.—Clamp handles.

Chaining Procedures and Chaining Party Organization

There are two basic methods for measuring distances with a tape. These methods are SLOPE CHAINING and HORIZONTAL chaining. In slope chaining, the slope distance is measured by holding the tape parallel to the slope of the ground and the corresponding horizontal distance is then computed by triangle solution.

In horizontal chaining, the tape is held horizontal, regardless of the slope of the ground, and the relevant tape graduations are extended to the ground by plumb bob and cord, as shown in figure 5-24.

The basic chaining party consists of two men: a REAR CHAINMAN who holds his end of the tape on the starting point and a HEAD CHAINMAN who carries the other end of the tape and makes the measurement. In more precise work a STRETCHERMAN may be added. The stretcherman keeps the correct tension on the tape while the chainmen are doing the measuring. If there is no designated RECORDER, the head chainman records the measurements in a field notebook along with any other pertinent data. There may also be a FLAGMAN assigned, who holds a range pole on a forward station to define the line to be measured. Where there is much brush or other natural growth, one or more AXMEN may be assigned to clear the line ahead. As a non-rated SEABEE, you could be assigned to perform any of the above duties. Listen carefully to your instructions from the party chief and doublecheck your work as you move along.

If assigned as rear chainman, it will be your job to hold the tape and plumb bob over the last point measured. Figure 5-25 illustrates the correct way of holding when "plumbing high" and when "plumbing low". The plumb bob should be lowered until it is about 1/8 inch from the point marker.

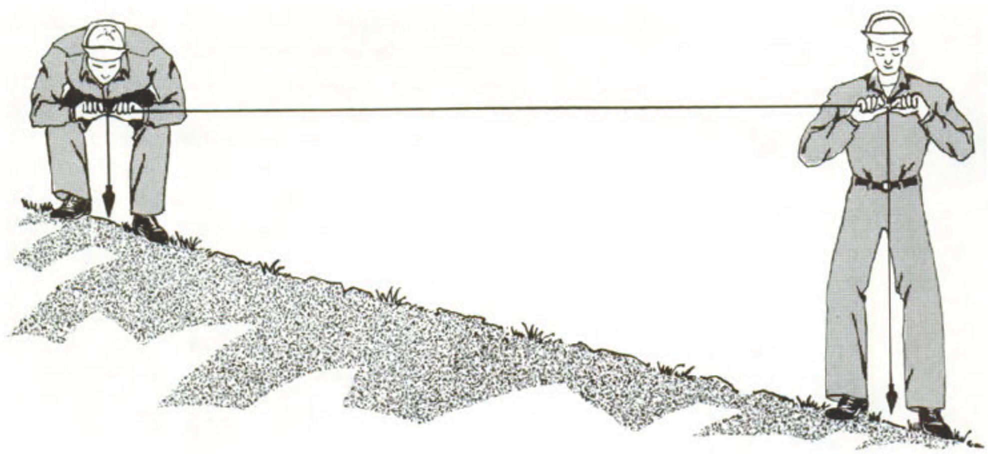
VERTICAL CONTROL

Concurrent with, or immediately after, the establishment of horizontal control on a construction project comes the establishment of VERTICAL CONTROL—that is, the establishment of a pattern or framework of reference points (called bench marks) over the site, from which elevations in the vicinity of each can be determined.

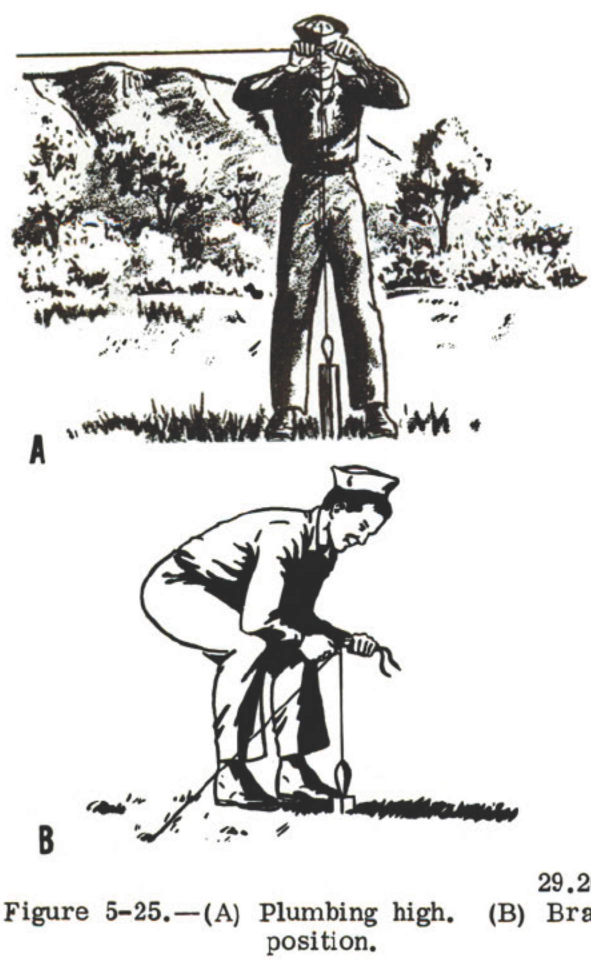
Bench Marks

A BENCH MARK (BM) is, by definition, ANY FIXED OBJECT WHICH CAN BE LOCATED AND WHICH HAS A KNOWN ELEVATION. By "fixed object" we mean an object that is not likely to be moved any time during the construction phases. Such an object might be a concrete monument, a manhole cover, a nail in a tree, or a chiseled mark in a rock outcropping.

The starting point for the establishment of vertical control is always a preestablished bench mark. If geographical elevations (vertical distances above or below mean sea level) are to be used, one of the permanent bench marks established by Government agencies may be available. However, it is often the case in construction work that an object on or near the site is selected as a starting bench mark. It would be given



29.261
Figure 5-24.—Horizontal chaining over sloping ground.



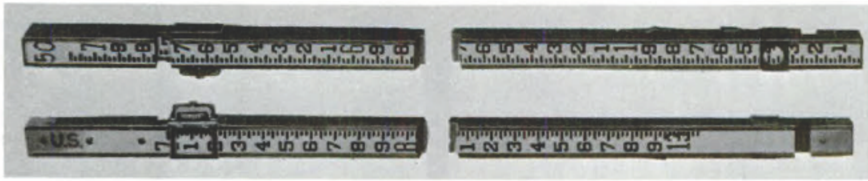
29.265A
Figure 5-25.—(A) Plumbing high. (B) Braced position.

an assumed elevation, such as 100.00 feet, and all elevations of buildings, driveways, utilities, etc., in the vicinity would be prescribed in reference to this assumed elevation.

Procedures for Leveling

As vertical control is essentially a process of determining a number of different levels (called elevations), the procedure used is called LEVELING. Leveling may be either DIRECT or INDIRECT, depending on how the vertical measurements were determined. When direct leveling is used, measurements are read directly from tapes, rulers, or more usually level rods (explained later). Differential leveling, explained earlier and illustrated in figure 5-5, is the most commonly used method of direct leveling. When indirect leveling is used, elevations are determined by other than direct measurement, usually by triangulation. Figure 5-8 illustrated a simple use of indirect leveling.

LEVEL ROD.—Besides the engineer's level, the principal item of equipment used in direct leveling is the level rod. Some rods are designed for direct reading by the instrumentman. Others are designed for reading by the man holding the rod (called RODMAN). The level rod most frequently used by SEABEES is the "Philadelphia" rod. It consists of two sections, upper and lower, which can be closed or extended. The rod, slightly extended, is shown in figure 5-26; the upper picture is the face of the rod and the lower one illustrates the back of the rod. If the rod is

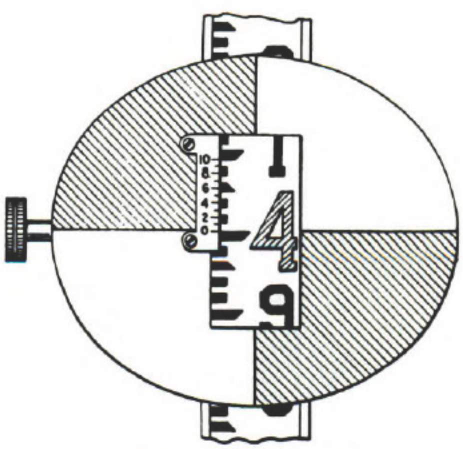


29.267
Figure 5-26.—Face and back of Philadelphia rod.

close enough to be read by the instrumentman, direct readings can be taken. For more distant observations, the sliding target shown in figure 5-27 can be set by the rodman on signal from the instrumentman. The sliding target is read by the rodman and the elevation signaled back to the instrumentman/recorder.

The rod is graduated for reading measurements to the nearest 0.01 foot. Every 0.10-foot interval in each 1.00-foot interval is numbered with a small black numeral. Each 1.00-foot interval (from 1.00 foot to 7.00 feet on the front of the rod; from 7.00 feet to 13.00 feet on the back of the rod) is numbered with a large red numeral. The hundredths in each tenth-of-a-foot interval are indicated by the small black horizontal dashes, the bottom of the first dash indicating 0.01 foot, the top of the same indicating 0.02 foot, the bottom of the second dash indicating 0.03 foot, and so on.

BACKSIGHT AND FORESIGHT.—Each time an instrument is set up and leveled, the instrumentman must determine the new H.I. To do this, he takes a BACKSIGHT (BS) on a level rod held on a bench mark or on the last known point of elevation. For example, in figure 5-5 when the instrumentman sights back to point A (BM EL. 365.01 ft) he is in fact taking a backsight. A FORESIGHT (FS) is the sight taken ahead to the new point which is to be determined.



CROSS HATCHING INDICATES RED

29.267
Figure 5-27.—Philadelphia rod sliding target.

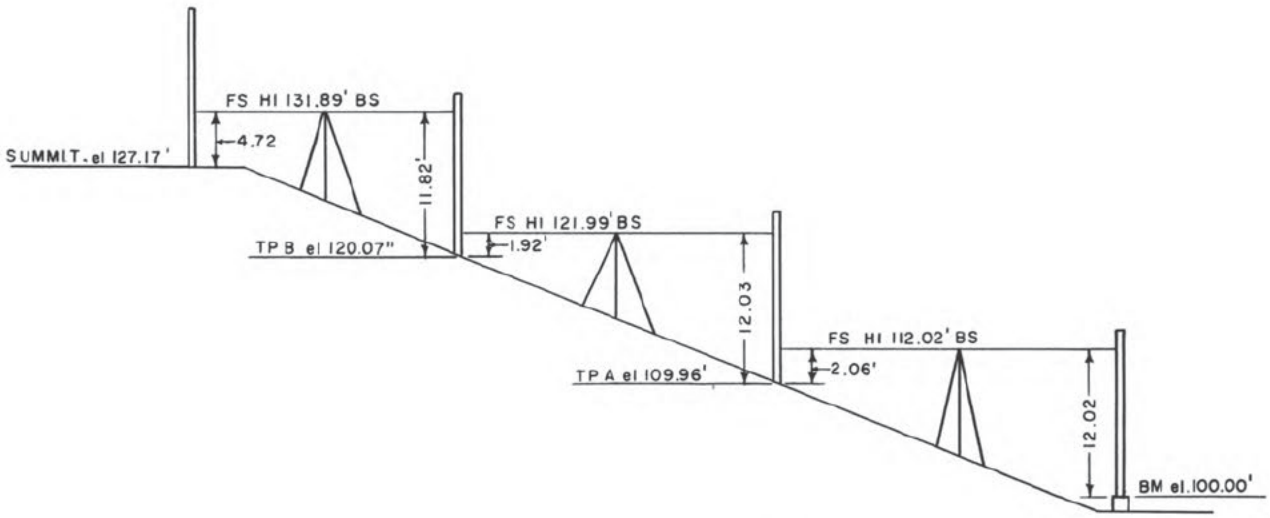
TURNING POINTS.—Suppose that, as shown in figure 5-28, a level party wants to establish a BM at the top of a slope; and the nearest existing BM (in this case, the nearest point of known elevation) is at the foot of the slope, some 30 feet below. Obviously, this cannot be accomplished with a single instrument setup. Instead, the elevation is carried up the slope, as shown in the figure, by way of a series of TURNING POINTS (TPs). A TP is simply a point where you determine the elevation only for the purpose of carrying on the level run. Note that a turning point is a foresight station for one setup and then a backsight station for the next setup.

Duties on Leveling Parties

Earlier it was explained that as Constructionman you may perform the duties of the rodman. Although at times you may help clear-the-line—cutting brush, etc.—the primary task of the rodman is holding and giving sights with the level rod.

The first consideration in holding a rod is to be absolutely certain that you set the rod on the correct BM or TP. Next, it is essential that the base of the rod be absolutely clean—free, for example, of any clinging clumps of soil, stones, and the like.

Finally, it is absolutely essential that a level rod be held perfectly plumb. Obviously the reading of a rod which is held out of plumb will be greater than the actual vertical distance. Usually, a beginner rodman is required to use a small rod level like the one shown in figure 5-29.



45.41
Figure 5-28.—Turning points.

This is called a "bull's-eye" rod level and it tells the rodman whether or not the rod is plumb.

If you are holding the rod a little out of plumb to one side or the other, the instrumentman can see this by "eyeball," and signal for a correction. However, if you are holding it a little out of plumb toward or away from the instrument, the instrumentman cannot determine this by eye. To ensure a plumb rod, he may call out, or signal you, to WAVE THE ROD.

To wave the rod, swing the rod slowly in an arc toward and away from the instrument. As you do this, the instrumentman's reading will increase, decrease to a minimum, and increase again. The minimum reading he gets will be the plumb rod reading.

Surveyor's Hand Signals

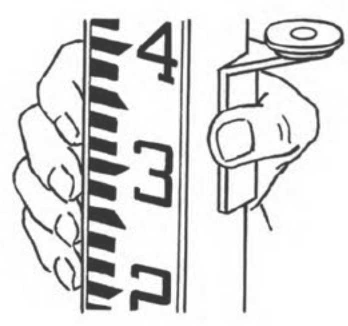
Surveys are often made in locations where distances are too great for giving instructions to the rodman, flagmen, etc., by voice. Too, construction equipment working nearby may make considerable noise. Experienced surveyor's take pride in being able to conduct all surveys through the use of standard hand signals. However, as a general Constructionman, you are not required to know them. If you are assigned to a survey crew or party you will receive instruction on the basic signals. The majority are common sense and easily learned. If you are interested in striking for EA, you can show your interest by learning the signals in Engineering Aid 3 & 2 (NAVPERS 10634-B).

CARE OF SURVEYING EQUIPMENT

Even though you, as a general Constructionman, are not required to know how to operate or use much of the equipment employed in surveying, it is possible that you will be asked to help carry and set up instruments and to use tapes/chains and level rods.

Instruments

Engineer's levels, transits, alidades, and the like are all precision instruments, which contain many delicate and some fragile parts. They



45.40
Figure 5-29.—Bull's-eye rod level.

must be handled gently and with the greatest of care at all times, and they must never be shocked or jarred.

An instrument not in actual use should always be stowed in its carrying case or box, with level screws and clamp screws tightened slightly to prevent motion of parts inside the case. The carrying case is designed to reduce the effect of jarring, and is strongly made and well padded to protect the instrument from damage. When instruments are being transported by vehicle, the carrying case should be placed about midway between front and rear wheels, this being the point where the bouncing of the wheels has the minimum effect.

Never lift instruments out of their carrying case by grasping the telescope; wrenching the telescope in this manner will damage a number of delicate parts. Always lift the instrument out by grasping the footplate.

When instrument and tripod are to be carried from one setup point to another, the level and clamp screws should be loosened slightly—that is, they should be tight enough to prevent the telescope from swinging and the instrument from sliding on the footplate, but loose enough to allow a "give" in case of an accidental bump against an obstacle.

When carrying instrument (and tripod) over terrain which is free of possible contacts (across an open field, for example), you may carry it over your shoulder like a rifle. However, if there is any possibility of encountering obstacles, the instrument should be carried as shown in figure 5-30.

45.93
Figure 5-30.—Safest carrying position for instrument when obstacles may be encountered.

Tripods

Tripods should be kept clean. The tripod head should always be kept covered with the PROTECTOR CAP whenever an instrument is not attached. The protector cap, when not in use, should be placed in the carrying case to prevent dust and dirt from getting on the threads. Never put oil on the threads of the tripod head or in the protector cap. Remove dirt from the threads with an old toothbrush. When setting up or securing a tripod, always loosen the wingnuts before opening or closing the legs.

Tapes/Chains

If a steel or metallic type gets a kink in it, and is then subjected to a strain, the tape will at best be distorted at the point where the kink lies. At worst, if the strain is strong enough, the tape will break at the point where the kink lies.

Kinks, therefore, are to be avoided at all costs; and most particularly, a strain on a tape with a kink in it must be avoided. When a tape is shifted ahead it may, under favorable circumstances, simply be dragged over the ground by the head chainman. It is not a good idea for the rear chainman to assist by dragging his end, as this develops a curve in the tape which may snag on an obstruction, and which also may be the cause of a kink. When a tape is being dragged, the rear chainman should simply allow his end to trail along. The cardinal rule is: "Keep the tape straight."

Tapes are made as corrosion-resistant as possible, but no steel tape is entirely immune to corrosion. Therefore, a tape should always be wiped dry before it is put away, and it should be oiled periodically with a light, rust-resistant oil. If a tape does rust, rubbing with a light steel wool dipped in a rust-removing compound is the best and safest way to remove the rust.

Level Rods

A leveling rod is a precision instrument and must be treated as such. Most rods are made of carefully selected, kiln-dried, well seasoned hardwood, with metal scale faces on which the

scale graduations and numerals are painted. Unless a rod is handled at all times with great care, the painted faces will become scratched, dented, or otherwise defaced. Accurate readings on a rod thus defaced are difficult.

Letting an extended rod close "on the run," by permitting the upper section to drop, tends to damage both sections of the rod, and may displace the vernier. Always close an extended rod by easing down the upper section.

A rod will not read accurately if it is not perfectly straight, and anything which might bend or warp the rod must therefore be avoided. Do not lay a rod down flat unless it is supported throughout by a flat surface. Never, of course, use it as a support or a lever. Store in a dry place to avoid possible warping and swelling from dampness, and always wipe a wet rod dry before stowing away.

If there is mud on the rod, rinse it off but do not scrub. If a soap solution must be used to remove grease, make it a mild solution.

Miscellaneous Equipment

Bags are provided for carrying stakes and hubs. They are usually canvas bags, equipped with a shoulder strap and strongly resembling a newsboy's bag. A newsboy's bag, in fact, makes an excellent carrying bag for stakes and hubs. So does a Navy seabag, equipped with shoulder strap.

Various types of leather or canvas bags and sheaths (such as chaining-pin quivers, plumb-bob sheaths, and sheaths for Abney and Locke levels) are provided for various items of equipment. Most of these can be attached to the belt. Leather pouches, also usually attachable to the belt, are available for carrying small tools, marking equipment, turning-point pins, and the like. In practice you will learn various convenient dodges, such as carrying your supply of surveyor's tacks stuck in a rubber ball, or in a piece of soft wood attached to your belt.

SURVEYING SAFETY

A surveying field party is frequently working its way through rugged terrain a long distance away from any professional medical assistance. Fighting through brush, felling trees, scaling bluffs, and crossing streams are all hazardous, as are the use of such edged tools as machetes, brush hooks, axes, and hatchets. Besides those dangers which are inherent in the work itself, a party may be exposed to a variety of natural dangers, such as those created by weather conditions, and by poisonous plants, reptiles, and insects. Occasionally in some areas there may be dangerous wild animals, or even dangerous domestic animals, such as vicious dogs or angry bulls. When a party is working along a thoroughfare on which vehicle traffic is proceeding as usual, there is the ever-present danger of being run down.

In the midst of such a variety of constant dangers, the only way to prevent injury is by the exercise of continual care and vigilance. Every man in a party must be aware of all existing hazards, able to recognize a hazardous situation, and trained to take appropriate preventive measures.

Construction Site Safety

Construction procedures and construction equipment are DANGEROUS, and a survey party working at a construction site is always in a dangerous situation. Where blasting or land clearing operations are going on, be sure that those crews know you are working in the area. Be alert at all times—particularly to listen for the warning shout of a blaster or of men felling trees.

When surveying near highways, railroads, or airstrips use red flagging generously, unless you are in a combat area. Place flagging on the legs of instruments and at a few places along the tapes. Put flags on level rods and range poles; and attach some flagging to your hat and also to the back of your shirt or jacket.

Think constantly of personal safety when working near heavy construction equipment. Let the equipment operators know you are in the vicinity. Likewise, alert other members in the crew if you are first to get the information. Remember that the equipment operator's view is often obscured by dust, curves, or by the equipment itself.

When ascending steep, rocky slopes, do not climb directly behind another man. If the man accidentally falls, or loosens a rock, or drops something, it might mean serious injury to you!

Weather Hazards

For all weather hazards the best preventive measure is the wearing of adequate protective clothing. When the weather is cold enough to induce frostbite, wear a hat which covers your ears, gloves or mittens, and woolen socks. It is the ears, fingers, and toes which are most susceptible to frostbite. Wear a hat when there is danger of heatstroke. A fair-haired or sandy-haired individual, even when he "tans," may be susceptible to a form of skin-cancer by exposure to sunlight. If you are in this category, better keep the skin covered whether you tan or not.

In general, when you set forth with a field party, wear or carry with you clothing which will provide adequate protection against the weather—not just as it is at the time you set forth, but as it may possibly develop before you get back.

Excavations

All excavations should have guardrails or barricades. However, if you are required to work close to excavations, always stay at least two feet from the edge. When chaining, avoid sudden tugs which would cause the other chainman to lose his balance.

Underground and Overhead Powerlines

Avoid all possible contact with ALL electric wires. Never throw a tape across electric wires. Even cloth tapes can become good conductors in the right circumstances. Avoid placing yourself in a position where you might fall against or across wiring in the event you slip. Above all, don't take chances around electric wiring or equipment.

First Aid

Every man in a field party should be an expert in first aid, regardless of the extent to which he may be junior in point of rate, authority, and experience. A chaining party may consist of only two men and, if the senior member is injured, it will be up to the junior to render first aid assistance. The SEABEE Combat Handbook and the Standard First Aid Training Course, NAVPERS 10081-B, are excellent references for brushing up on your first aid procedures.

DRAFTING

The term DRAFTING simply means drawing—that is, the representation of an object, or of an idea or concept, in a graphic medium, such as pencil, crayon, ink, or paint. Perhaps you have heard the expression "A drawing is worth a thousand words." Can you image a contractor trying to construct even the simplest of buildings entirely from verbal instructions? And, what about the translation from one language to another? Truly, the art of drawing has been aptly termed the "universal language;" and it is an art which the EA must master.

The EA must be able to prepare drawings from notes and sketches, as well as from verbal instructions. Generally, he works from sketches provided by a design engineer or from a surveyor's field notes. Occasionally, as he gains experience and becomes more proficient, he may prepare drawings of his own creation (design) for minor projects.

The information below is intended to give you an overall idea of what the SEABEE draftsman does and what equipment and supplies he uses.

TYPES OF DRAFTING

Primarily, the types of drafting fall into two major categories, depending on (1) the purpose of the drawing, either technical and illustrative, and (2) the method used to prepare the drawing, either mechanical or freehand.

Technical and Illustrative Drafting

A distinction is commonly made between technical drafting and illustrative drafting. A technical drawing is one which is intended principally for the purpose of presenting technical information in graphic form; a drawing which shows the arrangement of structural members in a building is an example. An illustrative drawing is one which is intended as a pictorial representation only; a Gilbert Stuart portrait of George Washington is an example. The fundamental distinction does not lie in the particular character of the drawing itself. The purpose is the deciding element. A portrait of Washington, for example, which was intended to show the details of the uniform of a general in the American Continental Army would be a technical drawing.

Mechanical and Freehand Drafting

As distinguished from freehand drafting, mechanical drafting is any drawing in which the pencil or pen is guided by mechanical devices, such as compasses, straightedges, and french curves. In freehand drafting the pencil or pen is guided solely by the hand of the draftsman. With the exception of freehand lettering, most technical drafting is mechanical drafting in this sense of the term.

Used in a different sense, the term "mechanical" is applied to certain types of industrial, engineering, or structural drawings, regardless of whether the drawing itself is done mechanically or freehand. Some authorities confine the term, used in this sense, to the drawing of machinery details and parts. Others confine it to the drawing of plumbing, heating, lighting, and ventilating systems in structures. Still others hold that it applies both to the drawing of machinery details and parts and to the drawing of plumbing, heating, lighting, and ventilating systems.

Engineering Aid Drafting

The EA is primarily concerned with the following broad types of drafting:

1. Drafting done in connection with topographic and civil engineering surveys. This is often collectively referred to as TOPOGRAPHIC drafting, even though it may include much drawing not directly related to topographic maps.

2. Drafting of architectural, structural, electrical, and mechanical drawings relating to structures. This is often collectively referred to as CONSTRUCTION drafting.

DRAFTING SUPPLIES AND EQUIPMENT

A draftsman makes his original drawing in pencil. In most cases a number of reproductions of the original are required. For reproduction purposes an ink tracing of the original is often made on a cloth overlay. The most common method of reproducing ink tracings is by an ammonia vapor (ozalid) process.

Drawing Paper

At one time, all original drawings were made on heavy, opaque drawing paper called DETAIL paper. Detail paper takes pencil well, but errors or changes are difficult to erase due to the heavy texture of the paper. Also, because the paper is opaque, all drawings have to be traced on other paper or cloth which is reproducible.

Because of these and other disadvantages, the use of detail paper for originals has largely given way to the use of tracing paper. TRACING PAPER is a high grade white (or slightly tinted) transparent paper which takes pencil very well, and from which pencil lines can be erased easily. Also, reproductions can be made directly from the originals.

Drawing Pencils

Drawing pencils are graded according to the relative softness or hardness of the lead. A pencil which is considered soft is designated B; one which is hard is designated H. With each letter designation there is usually a number designation which indicates the degree of softness or hardness. For example, the higher number B pencils are softer than the lower numbers; and the higher number H pencils are harder than the lower numbers. Drafting pencils are not equipped with erasers. Instead, several types of drafting erasers are manufactured for use with different mediums and paper. There are also many types of mechanical lead pencils available to the modern draftsman.

Drawing Pens

Occasionally, SEABEE draftsmen are required to make ink drawings. RULING PENS are used for this purpose and they may be either a "spring" type or a "hinged-blade" type as shown in figure 5-31. The ruling pen contains two broad, tapering steel blades called NIBS, which taper to a slightly curved point. The thickness of the ink line is controlled by adjusting the space between the points of the nibs. Other varieties of ruling pens are available for special purposes.

Lettering Pens

For freehand lettering with ink a draftsman may use a "quill" pen, or one of a variety of

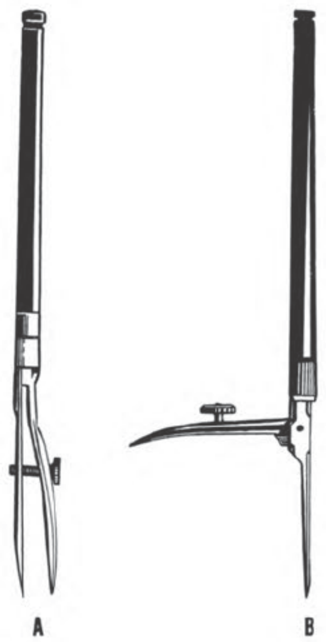


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Figure 5-31.—Ruling pens. (A) Spring type. (B) Hinged-blade type.

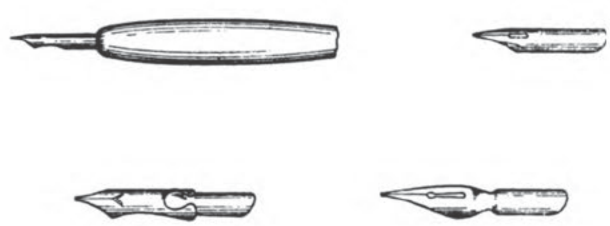

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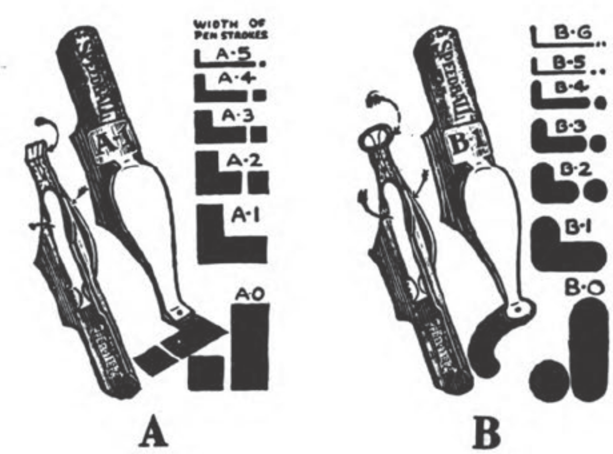
Figure 5-32.—Quill drawing pens.



45.124X
Figure 5-33.—Speedball pens.

special types of lettering pens. Some typical quill pens are shown in figure 5-32, and figure 5-33 illustrates two styles of special pens called SPEEDBALL PENS.

Some draftsmen prefer to do their lettering mechanically rather than freehand. Mechanical lettering pen sets consist of "templates" or "guides," which guide the pen. The pen is held in a three-legged device called a SCRIBER. Figure 5-34 illustrates the method of using a Wrico lettering set.

Drawing Board and T-square

Next to pencil, pen and paper, the drawing board and T-square (fig. 5-35) are the fundamental items of drafting equipment. The drawing board is made of soft, clear wood. Each of the four corners forms a right angle, each pair of opposing edges is parallel, and each of the four edges is usually true.

The T-square consists of a long strip of wood, plastic, or metal called the blade, and a crosspiece at one end called the head. The inner edge of the head forms a right angle with the upper (called working) edge of the blade. The T-square is used to draw straight, horizontal lines by holding the head against the "working edge" of the drawing board and marking along the working edge of the blade.

Triangles

Various sizes of 45-degree and 30-60-degree triangles are available and they are usually made of transparent plastic. They are used to make straight, vertical lines by holding one side of the 90-degree angle against the T-square and marking along the other. Various other angles and lines can be made by using the triangles as in figure 5-36.

Compasses

Circles and circular curves of relatively short radius are drawn with compasses like those

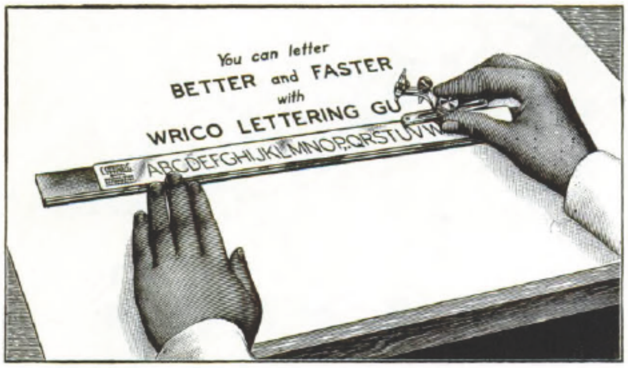


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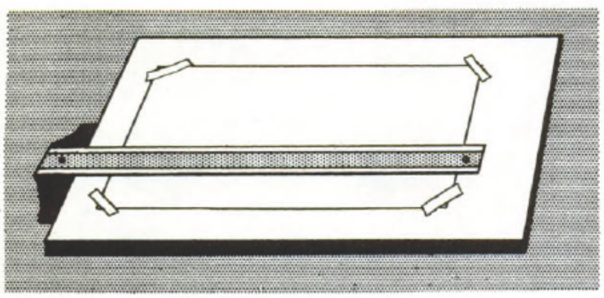
Figure 5-34.—Method of using Wrico lettering set.



29.275D
Figure 5-35.—Drawing board and T-square.

shown in figure 5-37. For drawing circles with large radii, the draftsman would use a BEAM COMPASS (fig. 5-38). Both the needlepoint attachment and the pencil or pen attachment can be slid up and down the "beam" and then locked at any desired position.

French Curves

Figure 5-39 illustrates an assortment of "french curves" that the draftsman uses to make noncircular curves, or circular curves of great radius. To do this, however, he must first plot a series of points as in (B), and then he will "fair" the curve through three or more points at a time.

Scales

Two of the most useful drafting tools are the ARCHITECT'S SCALE and the ENGINEER'S

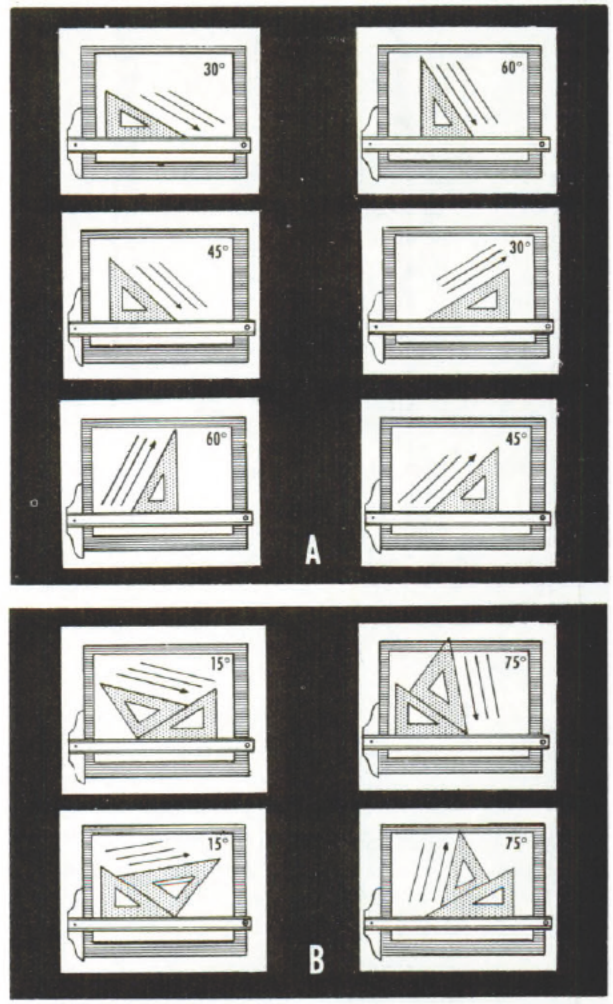


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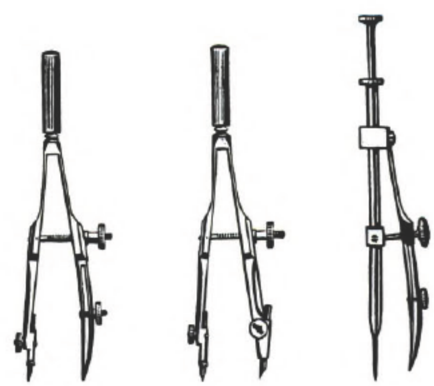
Figure 5-36.—Angles to the horizontal which can be drawn with T-square and triangles.



45.133
Figure 5-37.—Various draftsman's compasses.

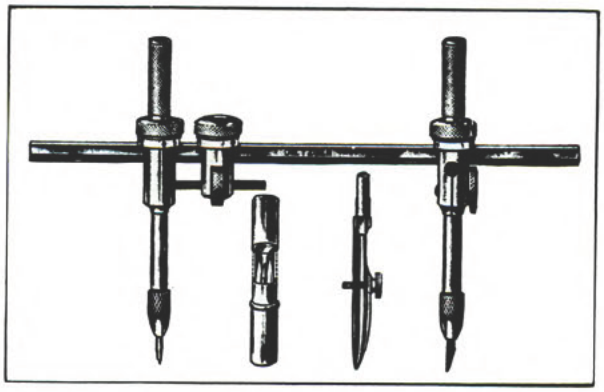


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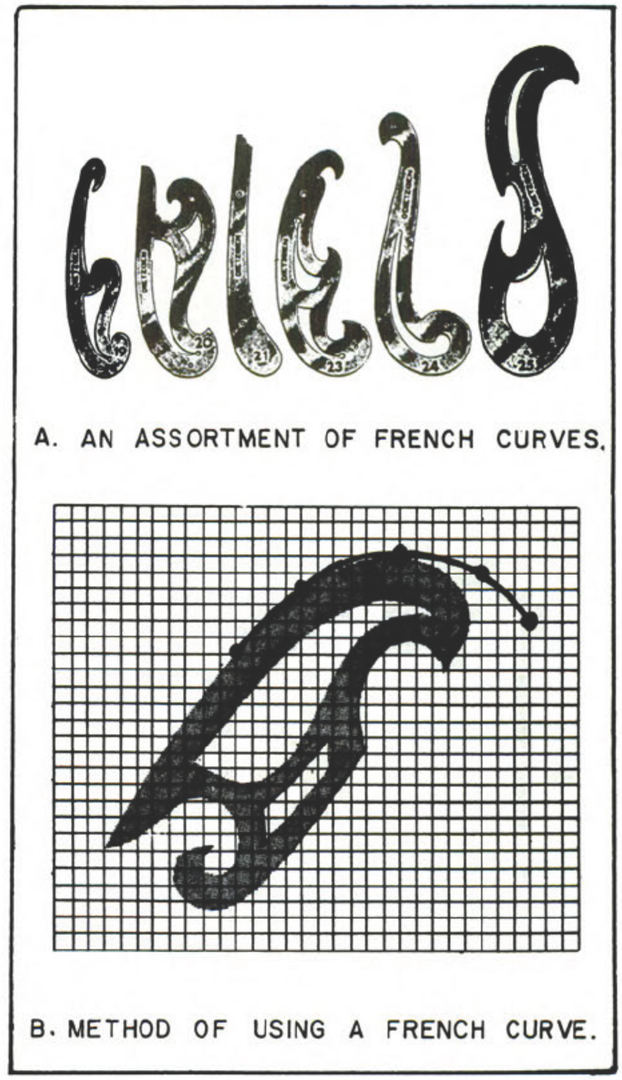
Figure 5-38.—Beam compass.



45.127X:.128
Figure 5-39.—French curves and how used.

SCALE (fig. 5-40). They are both used to layout or measure the dimensions of a drawing proportionately with the actual dimensions of the object or structure. In other words, they are used to make a drawing to scale. Generally, the drawing is smaller than the actual object (for example, a house plan) but in some cases the drawing may be larger than the actual object (for example, a very small machine part).

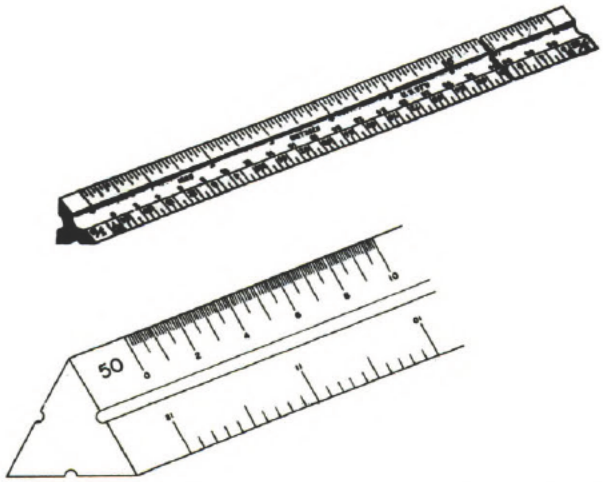
The architect's scale, which is subdivided into feet and inches (and fractions thereof), is principally used in construction drawings. However, it can be used for measuring any drawing which is represented in inches (or feet), such as the small machine part mentioned above.

The engineer's level has scales which are subdivided decimally, with each major interval on a scale being subdivided into 10ths. Each separate scale is designated by the number of graduations per linear inch on the scale. For example, the 10-scale has 10 graduations to the inch, the 50-scale has 50 to the inch, and so on. The engineer's scale is used for topographic mapping and plotting.

QUALITY CONTROL

Another major responsibility of the EA is QUALITY CONTROL. In general, this consists of the TESTING of construction materials to determine that they meet minimum quality requirements, and the INSPECTION of the actual construction to ensure that the planned construction methods are used and that prescribed work quality standards are met. Quality standards for both materials and workmanship are usually set forth in the job SPECIFICATIONS.

Specifications, commonly referred to as "specs" in the construction community, are written standards set forth by a recognized authority, regarding the types of materials, the quality of materials, and the standards of workmanship required of the contractor. In the absence of written job specifications, as is the case in much of the work done in combat areas,



4.16.1X:.45.135

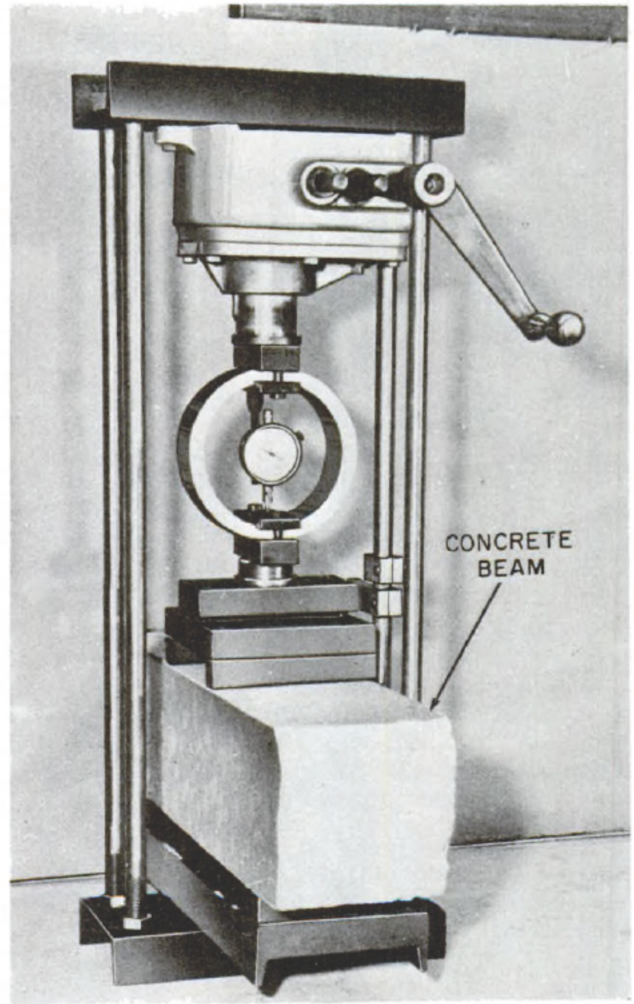
Figure 5-40.—Architect's scale (top) and a segment of an engineer's scale.

your supervisor establishes applicable quality standards, based on his experience and knowledge and on guidance provided by the Operations Department.

The EA doing quality control work spends a greater portion of his time in materials testing than in work inspection. Inspection is usually the responsibility of a selected few who have a wide range of experience in the construction field and/or have had special training. Inspection procedures are beyond the scope of this text.

The EA's work in materials testing generally involves the testing of soil, concrete, and bituminous materials. All this requires the use of much specialized equipment, such as the apparatus shown in figure 5-41, which is used for testing concrete beams. Many senior EAs are sent to a special school where they learn to become Quality Control Technicians. At this school they learn how to operate and use the various laboratory and field equipment and to conduct and analyze different material tests.

Existing soil at a construction site is sampled and tested to determine its bearing capacity—that is, whether or not it will support the weight of a proposed structure. If it is determined that the soil is not capable of supporting the proposed load, then corrective measures are incorporated into the design. Such measures might be the use of bearing piles or the widening of a footing to

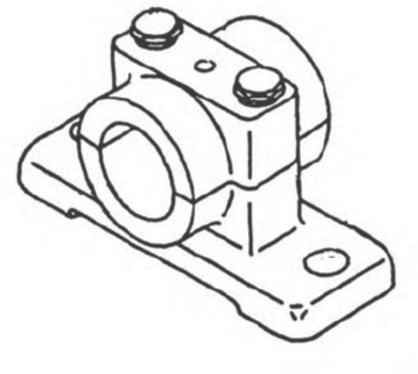


45.577

Figure 5-41.—Beam-breaker apparatus for concrete flexural strength test.

spread the load over a greater area. In other instances, the existing soil may be removed and replaced with a more suitable material, such as the gravel in a roadbed.

The testing of concrete and bituminous materials usually concerns the quality of the mix ingredients and the proportions of each in the mixture. The correct proportion is necessary in each case to ensure strength, durability, workability, and appearance. In concrete, for example, the quality controlman is concerned with the correct amount of cement, aggregate, and water; whereas, in a bituminous material, he would be concerned with the proper amount of binder



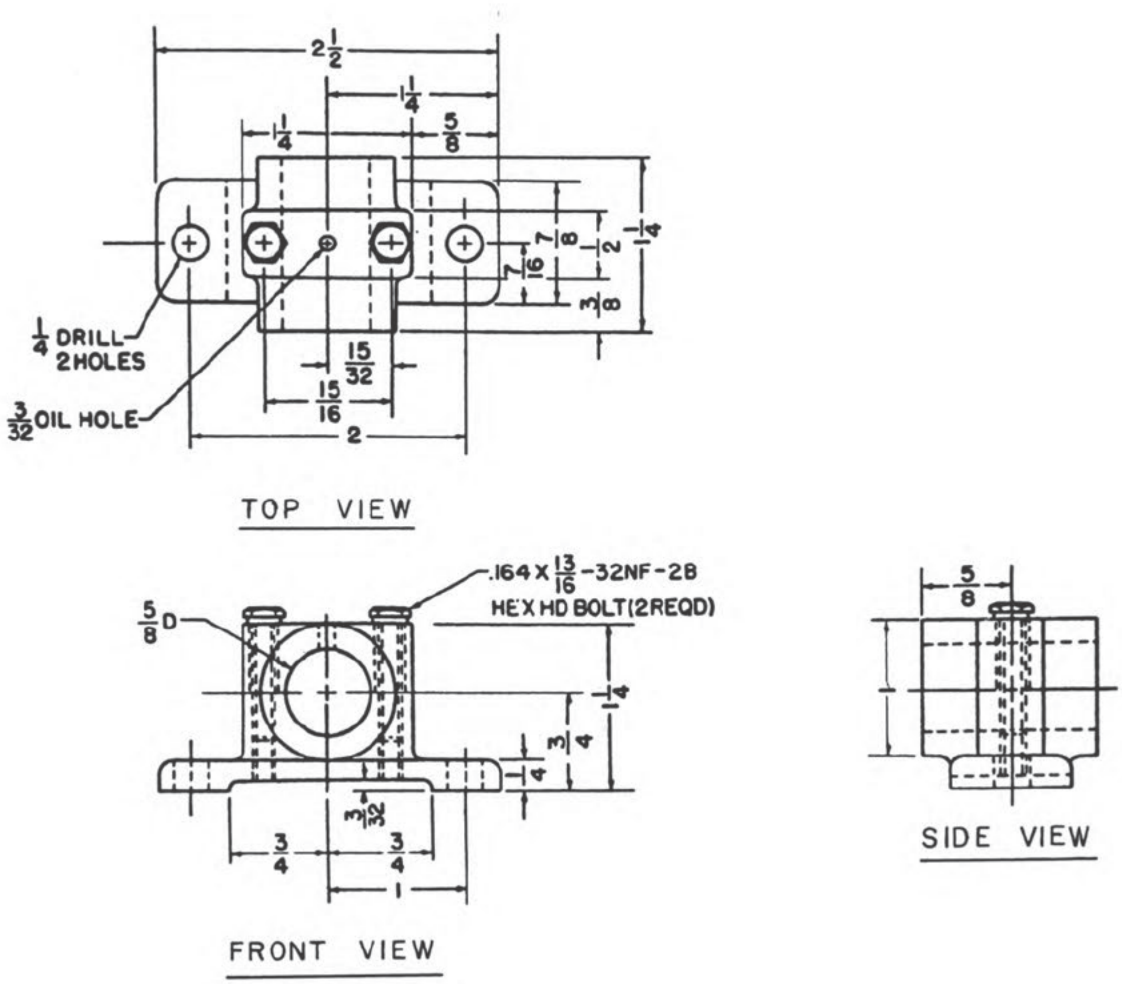
29.405
Figure 5-42.—Pictorial sketch of a "pillow block."

(bitumen or asphalt), the amount and graduation of aggregates, and the correct mixing temperature.

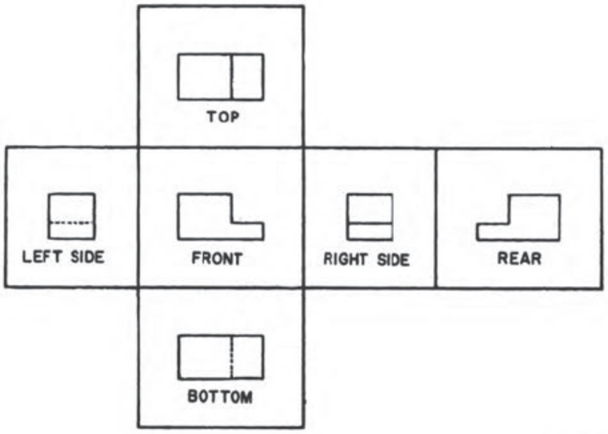
READING SKETCHES

All Constructionmen must be able to read simple sketches in order to efficiently perform routine construction tasks. Military sketching is covered in the SEABEE Combat Handbook. Sketching saves a great amount of time, as it reduces the amount of time required to explain a job and it helps reduce construction errors due to a misinterpretation of verbal instructions.

Most sketches are made "freehand;" however, it is not uncommon to use rulers, triangles,



65.44.0(29E)
Figure 5-43.—Multi-view technical sketch.



65.14
Figure 5-44.—Standard arrangement of multi-view sketches/drawings.

etc., in making "non-freehand" sketches to improve their appearance and to make dimensions more or less proportionate to the actual object.

Sketching may be either "pictorial" or "technical." A pictorial sketch may be equated to an illustrative drawing, such as we discussed earlier in the section on drafting. Figure 5-42 is a pictorial sketch, the intent of which is to illustrate the overall appearance of a "pillow block."

A technical sketch shows the same type of "technical" information that the technical drawing would show. For example, in figure 5-43, we find all the information required to make the pillow block previously illustrated. Note that it takes three views—front, side, and top—to include all the characteristics of the block. As a general practice, the front view is always given; the number of other views depends on the complexity of the object. Figure 5-44 depicts the standard arrangement of multi-view sketches or drawings.

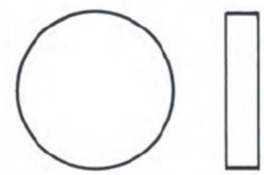
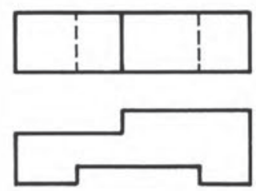
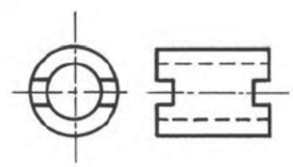
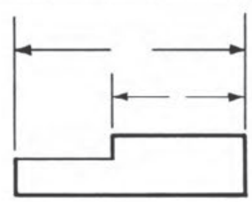
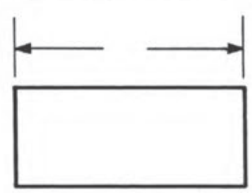
You have probably already noticed that in figure 5-43 there are several different types of lines used to depict various features of the pillow block, including those used to show the different dimensions. The meaning of each of these and other types of lines commonly used on sketches and drawings is pretty much standardized and these standards are known as LINE CONVENTIONS. In sketching, the weight (thickness and relative darkness) of all lines appears approximately the same; however, the type of line should not change. The most common line conventions are illustrated in figure 5-45. These, as well as their description and application, should be studied carefully. Figure 5-46 shows the use of many of these in a typical non-freehand technical sketch.

BASIC MATHEMATICS REQUIREMENTS

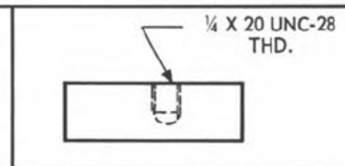
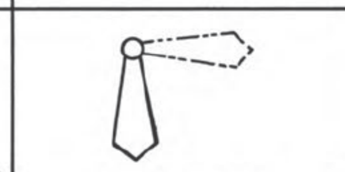
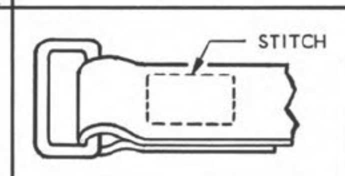
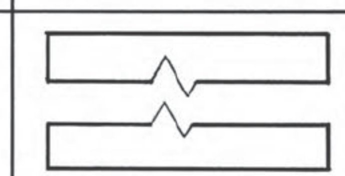
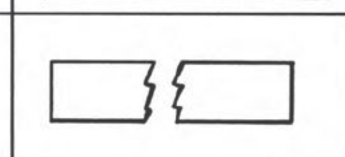
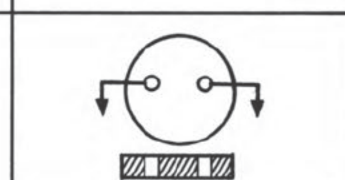
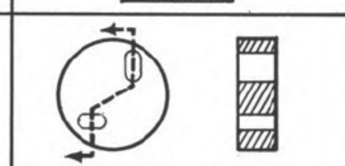
Mathematics is a basic tool to anyone who pursues any type of vocation or avocation; in fact, it is a part of our daily lives. The housewife, the grocer, the farmer, you name it, uses some form of math or arithmetic. If one can count, add, or subtract, he is dealing with arithmetic, which is a very basic form of mathematics. The importance of arithmetic to us cannot be overemphasized; that is why it was taught to us from the time we started in kindergarten or the first grade.

The use of math is found in every rating in the Navy, from the simple arithmetic of counting for inventory purposes to the complicated equations encountered in computer, electronics, research, and engineering work. Each rating, however, requires a different level of knowledge in math, depending upon its use in the rating. Among the Group VIII ratings, for example, the EA is looked upon to have a wider knowledge in math; that is because he uses a variety of math in solving problems in surveying, drafting, material testing, and so on. The EA must study in depth, the various operations in arithmetic, algebra, geometry, and trigonometry.

A basic knowledge of mathematics may be sufficient for some ratings. However, they should sufficiently learn arithmetical and algebraic operations necessary for computations they may encounter in their line of work. The BUs, for example, must be well versed in adding or subtracting mixed numbers and fractions because of their use of the carpenter's measure. The SWs must be well versed in decimals and fractions because they use them often in steelworking. The CEs and UTs must master algebra to such a degree that they can solve standard utility problems, such as electrical formulas (Ohm's Law), pipe formulas, and the like. The CMs and EOs must thoroughly learn arithmetic, particularly that portion which deals with adding or subtracting of whole numbers and decimals. In any case, however, it is to your advantage if you have the ability to solve all basic math problems. The higher you go up in rate in the Navy, the more you will need math, not only in the solution of

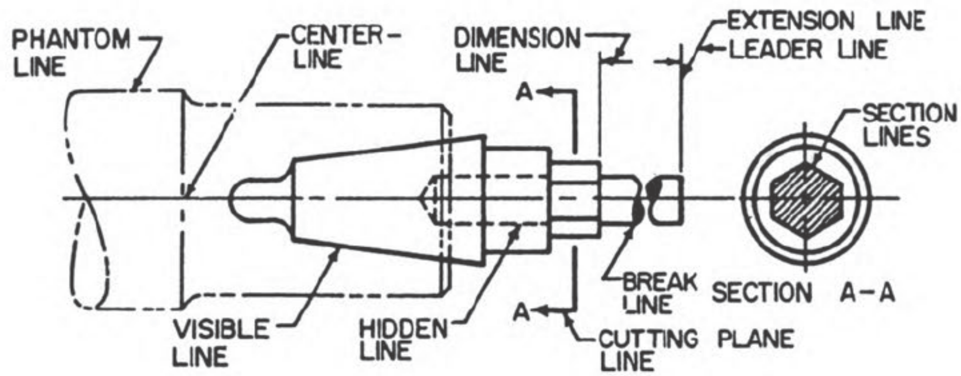
LINE STANDARDS			
NAME	CONVENTION	DESCRIPTION AND APPLICATION	EXAMPLE
VISIBLE LINES		HEAVY UNBROKEN LINES USED TO INDICATE VISIBLE EDGES OF AN OBJECT	
HIDDEN LINES		MEDIUM LINES WITH SHORT EVENLY SPACED DASHES USED TO INDICATE CONCEALED EDGES	
CENTER LINES		THIN LINES MADE UP OF LONG AND SHORT DASHES ALTERNATELY SPACED AND CONSISTENT IN LENGTH USED TO INDICATE SYMMETRY ABOUT AN AXIS AND LOCATION OF CENTERS	
DIMENSION LINES		THIN LINES TERMIMATED WITH ARROW HEADS AT EACH END USED TO INDICATE DISTANCE MEASURED	
EXTENSION LINES		THIN UNBROKEN LINES USED TO INDICATE EXTENT OF DIMENSIONS	

142.46.1
Figure 5-45.—Line conventions.

NAME	CONVENTION	DESCRIPTION AND APPLICATION	EXAMPLE
LEADER		THIN LINE TERMINATED WITH ARROWHEAD OR DOT AT ONE END USED TO INDICATE A PART, DIMENSION OR OTHER REFERENCE	
PHANTOM OR DATUM LINE		MEDIUM SERIES OF ONE LONG DASH AND TWO SHORT DASHES EVENLY SPACED ENDING WITH LONG DASH USED TO INDICATE ALTERNATE POSITION OF PARTS, REPEATED DETAIL OR TO INDICATE A DATUM PLANE	
STITCH LINE		MEDIUM LINE OF SHORT DASHES EVENLY SPACED AND LABELED USED TO INDICATE STITCHING OR SEWING	
BREAK (LONG)		THIN SOLID RULED LINES WITH FREEHAND ZIG-ZAGS USED TO REDUCE SIZE OF DRAWING REQUIRED TO DELINEATE OBJECT AND REDUCE DETAIL	
BREAK (SHORT)		THICK SOLID FREE HAND LINES USED TO INDICATE A SHORT BREAK	
CUTTING OR VIEWING PLANE VIEWING PLANE OPTIONAL		THICK SOLID LINES WITH ARROWHEAD TO INDICATE DIRECTION IN WHICH SECTION OR PLANE IS VIEWED OR TAKEN	
CUTTING PLANE FOR COMPLEX OR OFFSET VIEWS		THICK SHORT DASHES USED TO SHOW OFFSET WITH ARROWHEADS TO SHOW DIRECTION VIEWED	

142.46.2

Figure 5-45.—Line conventions—continued.



65.12
Figure 5-46.—Application of line conventions.

problems related to your rating, but also in other functions, such as P & E, competitive examinations, management, and so on.

It is believed that your basic math requirements will be met quite sufficiently, if you study thoroughly Mathematics, Vol. I, NavPers 10069-C. In case you already have a good knowledge of mathematics but need to brush up on the subject, you will find it beneficial to spend some time in reviewing Mathematics, Vol. I.

CHAPTER 6
CONSTRUCTION SITE PREPARATION AND EARTHWORK

The final location of new construction projects undertaken by the SEABEES is dictated, ordinarily, by military necessity. The general area is normally pin-pointed by higher authorities, but the actual location is selected by SEABEE engineers or engineers of the other services when the SEABEES' task is to support them.

As in any other major construction project, the actual site is chosen only after careful engineering studies and evaluations. Generally, reconnaissance parties are dispatched, well in advance, to the general area of the proposed project, to collect various engineering data which will be the basis for selecting the actual construction site. Once the site is agreed upon, then the SITE PREPARATION begins.

EARTHWORK OPERATIONS

In the construction of roads, airfields, buildings and other such structures, some earthwork operations generally are required to prepare the sites for new construction. Irregularities of the ground must be removed or reduced by cutting off high spots and filling in low places. This cutting and filling process is known as EARTHWORK or EARTHMOVING.

But, before earthmoving begins, a number of other operations frequently are required. For example, in preparing a site for construction of an airfield such operations as clearing and grubbing, stripping, and ditching often must be performed before cutting and filling is started. Bear in mind, though, that the earthwork operations for one project may not be the same as for another project. The types and extent of operations depend largely upon the size and kind of job and the equipment available.

CLEARING AND GRUBBING

CLEARING is ridding an area of trees, brush, vegetation, and rubbish, and disposing of all these materials. GRUBBING is the uprooting and removal of roots and stumps. Equipment commonly used in clearing and grubbing includes bulldozers, front-end loaders, rippers, power-operated winches, power saws, and handtools.

At the very beginning, the construction site may be covered with vegetation as thick as that shown in figure 6-1. Here an EO is making his first run through the thickets. To a lesser entent, where the construction site is clear of trees and depending upon the workability of the soil, motor graders and scrapers may be the main equipment used.

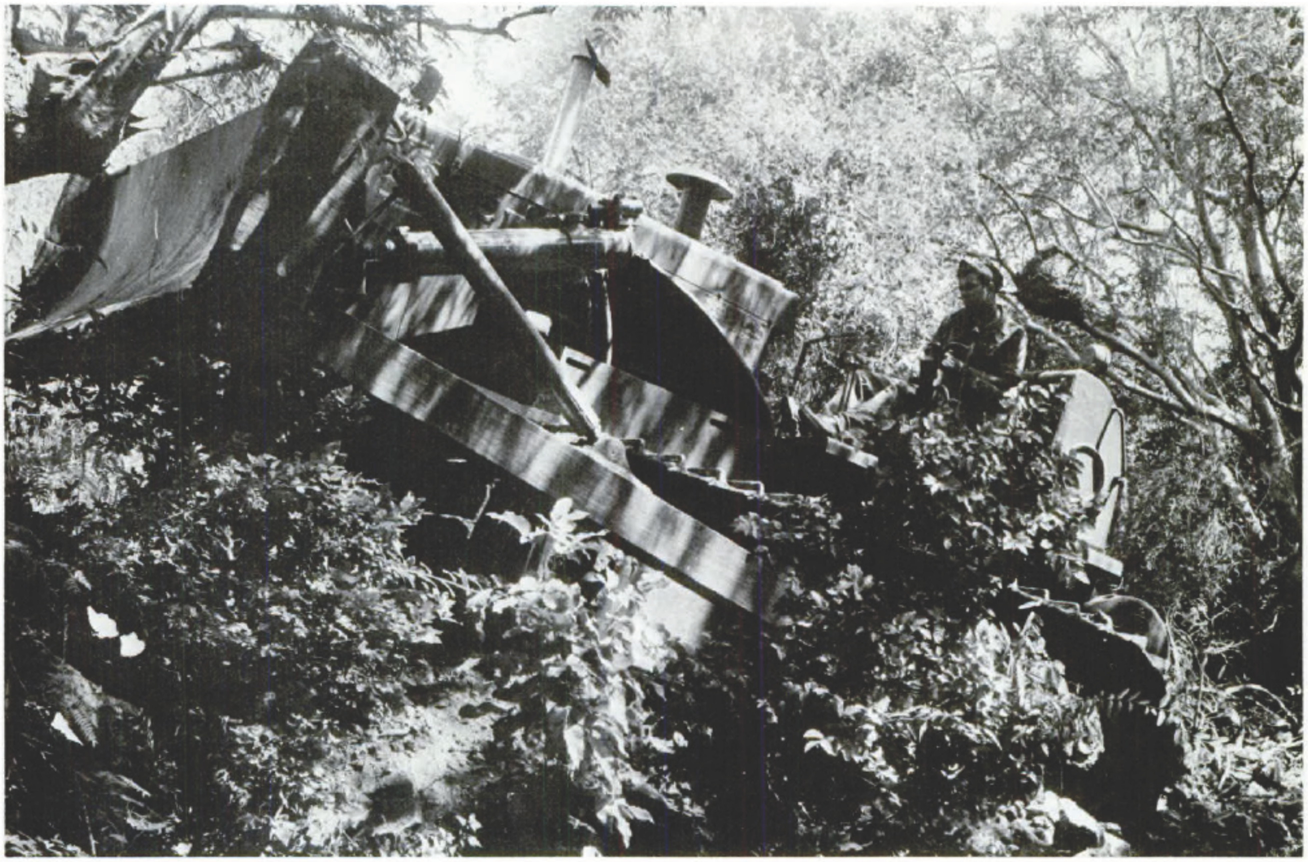
The bulldozer is one of the most efficient types of equipment available for land clearing operations. It is outstanding for pushing, pulling, or skidding cleared material for disposal, and can be used with excellent results for removing small bushes and trees and for uprooting small trees and stumps (fig. 6-2). It is capable of removing larger trees but the method used is slow (fig. 6-3).

Usually, the brush, trees, and stumps are piled on the site and burned. However, in some instances, timber that is removed may be manufactured into poles, posts, ties, squared timbers for heavy structures, or other useful products.

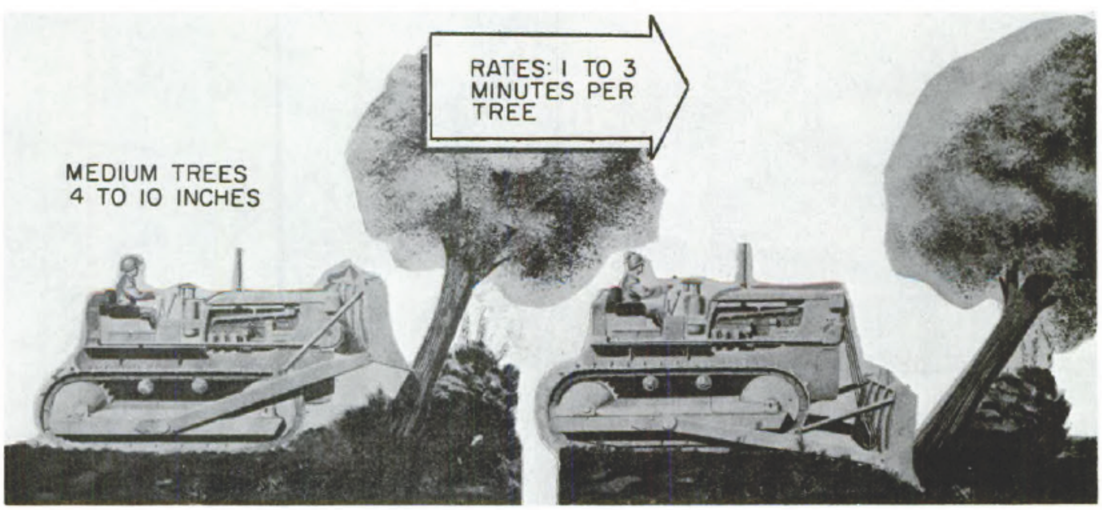
On many projects, stumps are removed by pulling them out with a winch. For very deep-rooted or stubborn stumps, other removal methods such as blasting or burning may be necessary. When stumps are to be removed by blasting, a qualified blaster will be called upon to do the job.

When stumps and roots have been removed, the holes must be filled and compacted as required. In addition, the surface will probably have to be plowed and harrowed. If the stumps are to remain, the trees are cut as close to the ground as possible to prevent undue interference with later operations.

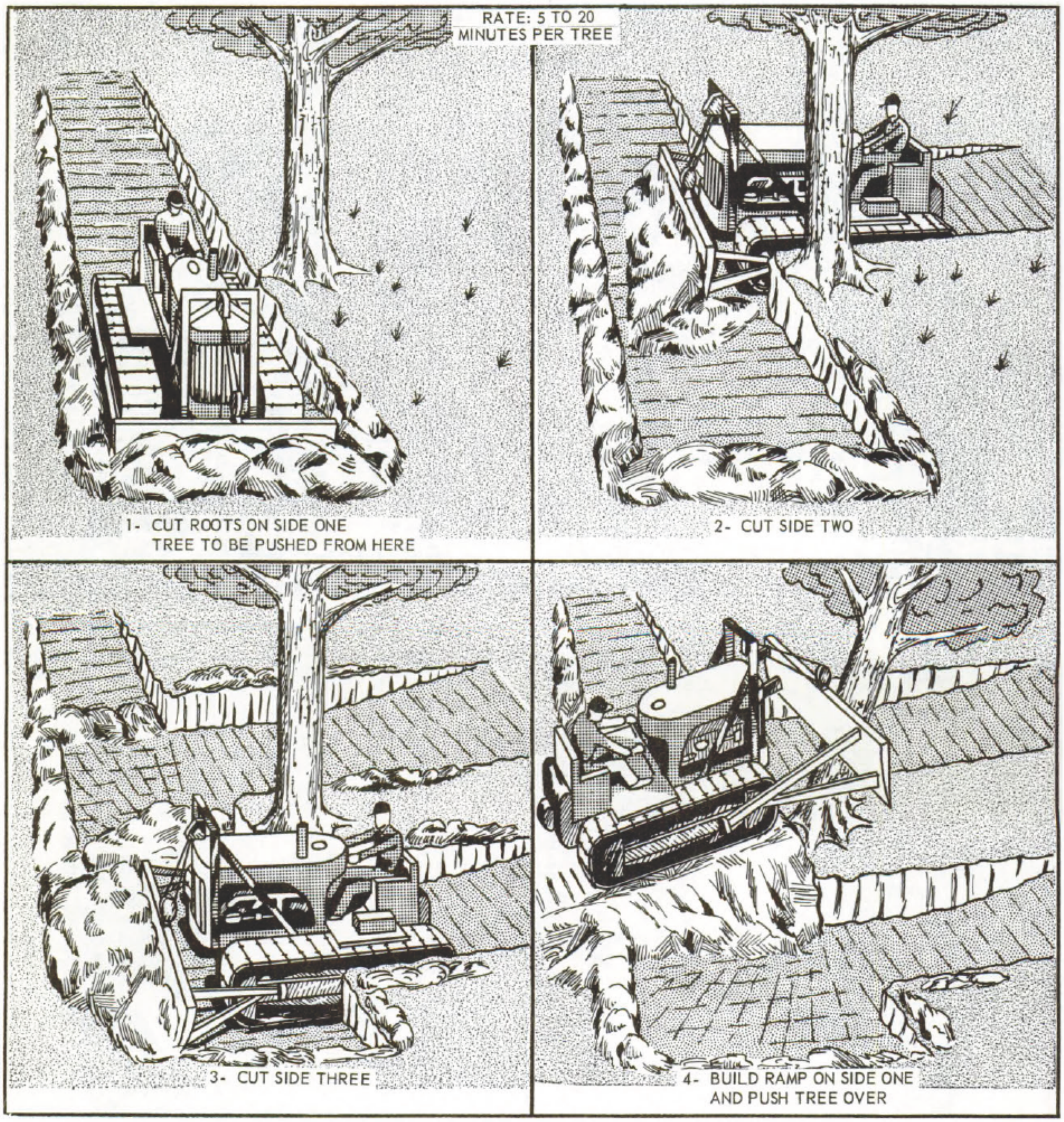
There are many hazards associated with clearing and grubbing. If you are assigned with the clearing and grubbing crew, you should be



29.406
Figure 6-1. — An EO ponders his method of attack while making his first run through thickets during clearing and grubbing operation.



29.76
Figure 6-2. — Bulldozer removing medium-sized trees.



115.58
Figure 6-3. — Steps in removing large trees with bulldozer.

extra careful when working around operating equipment. Make sure you stay clear of the equipment and exercise care to avoid hazards that may be triggered by moving equipment; for example, the dangers of being swiped by falling trees or underbrush and by the backlash of snapping vines, branches, roots, and the like.

You may be exposed to poisonous plants, insects, and reptiles. The most common poisonous plants that you should watch for are poison ivy (including a variety called POISON OAK) and POISON SUMAC. These plants contain and exude a resinous juice which produces a severe reaction when it comes in contact with the skin of the average person. The first symptom of itching or a burning sensation may develop in a few hours or, in some cases, after a few days. The itching sensation and subsequent inflammation that usually develops into watery blisters under the skin may continue for several days from a single contamination.

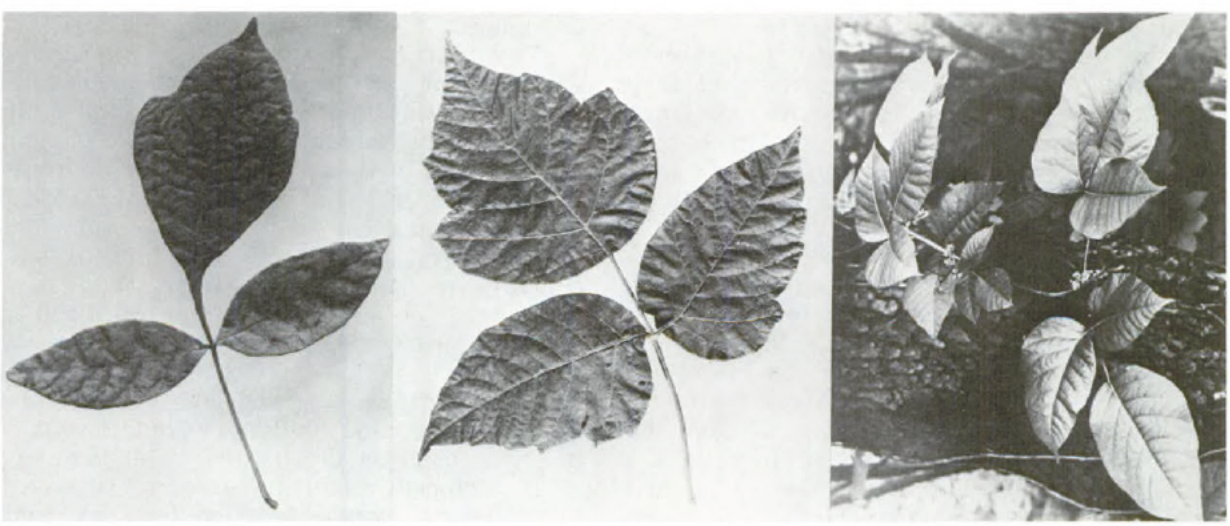
The resinous juice exuded by these poisonous plants does not dry up easily. Consequently, it may be carried on clothing, shoes, tools, or soil for long periods, and may thus infect persons who have not actually come into contact with the plants themselves. In fact, individuals have been severely infected by juice carried through the air by smoke from burning plants. Others have been infected by juice carried on the fur of animals.

To avoid contact with these plants, you must have an idea of what they look like. Poison ivy is a "three-leaflet" plant as shown in figure 6-4. The upper surface of the leaflet has a shiny, varnished appearance. The variety called poison oak has a leaflet with "serrated" or "lobed" edges like that of an oak leaf, as shown in figure 6-5. Ordinary poison ivy is usually a vine, poison oak usually a bush. In the flowering season, both types produce clusters of small white berries.

Different varieties of poisonous sumac leaves are shown in figure 6-6. There are poison sumacs and harmless sumacs, and it is difficult to distinguish the leaf of one from the leaf of the other. The only way to tell the poisonous plant from the harmless is by the fruit. Both plants produce a drooping cluster-type fruit. The difference lies in the color of their fruits — that of the harmless sumac is RED; that of the poison sumac is WHITE.

Outside of fruit season, better avoid contact with all sumacs!

First aid consists entirely of preventive measures to be taken when you have contacted a poisonous plant. If you have reason to believe that you have been infected, wash the affected area thoroughly with water and alkaline laundry soap. Do not use ordinary bath soaps, because they are oily and will only spread the juice. Lather profusely, and do not rinse the lather off, but allow it to dry on the skin. Repeat this



45.83(45B)
Figure 6-4. — Different varieties of poison ivy leaves.

45.84(45B)
Figure 6-5. — Poison oak (leaves and fruits).

procedure every 3 or 4 hours, in each case allowing the lather to dry. If itching of the affected area persists, report to sickbay — treatment must be as prescribed by a doctor.

If your work makes contact with these plants unavoidable, you must wear gloves and long sleeves and keep all skin areas covered. When you remove your clothing, take care not to allow any skin area to come in contact with the exposed clothing area. Launder the clothing at once.

The hazards of being bitten by poisonous insects and snakes in a newly opened construction area are ever present. Among the insects, watch for bees, spiders, and scorpions. Most people are not bothered by bee stings, but in a few cases the victim suffers horrible ill effects. The most poisonous insects, however, are the SPIDERS and SCORPIONS. These insects are common in almost all parts of the world, and some of the more venomous varieties can cause serious poisoning. Adults rarely die from spider bites or scorpion stings, but they are often made seriously ill by them. First aid measures for spider bites and scorpion stings are limited. If bitten or stung by these insects, clean the wound and surrounding area with alcohol to get rid of the bacteria. The victim should be observed for signs of shock; keep him lying down, quiet, and warm. Severe muscle cramps and pain may sometimes be relieved by warm-water baths.

Bites by poisonous SNAKES are very dangerous, and may cause death if the victim is not treated right away. Generally, snakes are afraid of human beings. They will try to avoid you if they can; however, they will strike if they are surprised, cornered or hurt. Do not play with them. If you don't know the difference between a poisonous snake and a nonpoisonous one, it is best to stay away from all snakes. If you are in doubt, the best general rule is to treat every type of snake as poisonous. The Standard First Aid Training Course, NavPers 10081 (revised), explains how, after you have been bitten by a poisonous snake, you can tell from the bite or symptoms whether or not the snake was poisonous. NavPers 10081 also prescribes first aid measures for persons bitten by poisonous snakes.

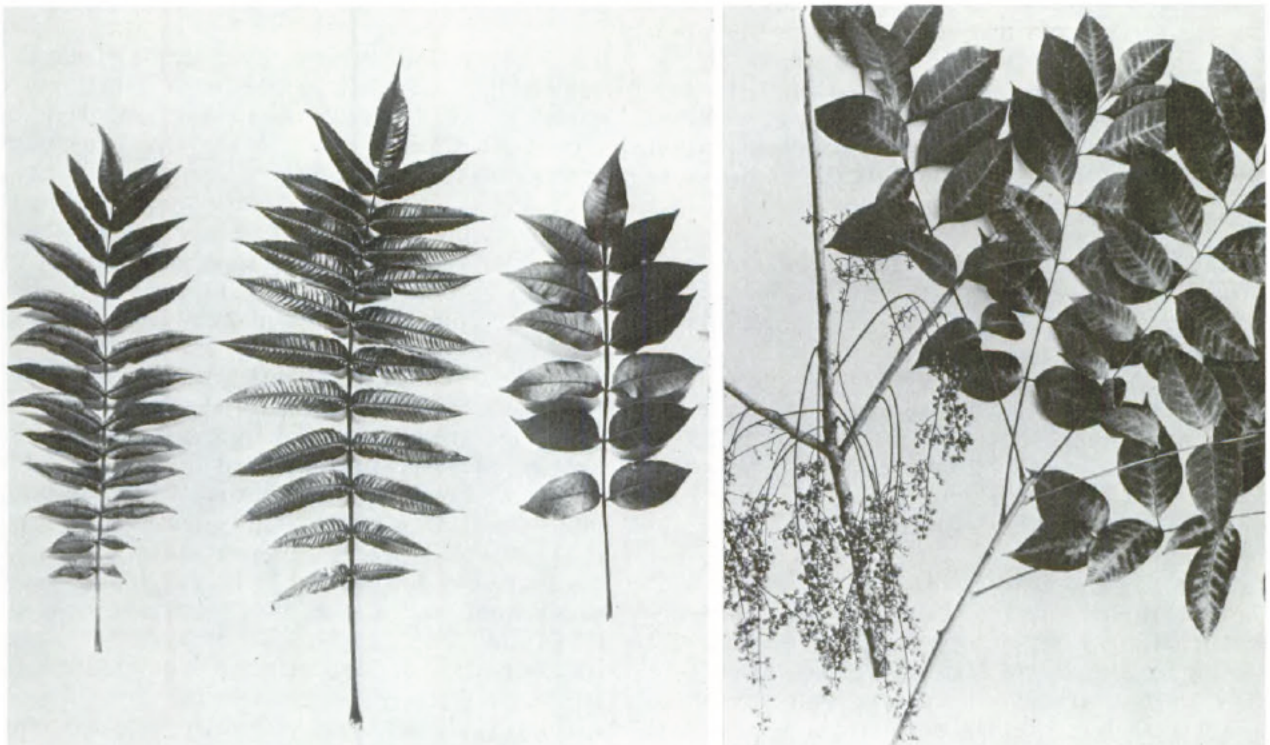
STRIPPING

Another operation required in certain types of construction, such as roadway and airfield construction, if STRIPPING. In earthwork, stripping means the removal of topsoil and sod which would be objectionable as a foundation under a fill or as a subgrade. Examples of this type of material include organic soils, humus, peat, and muck.

The stripping operation is accomplished along with clearing and grubbing. The dozer makes a very efficient piece of equipment for stripping when the haul distance is short. For long hauls the scraper will do the job more efficiently.

Good topsoil and sod often are stockpiled at a location clear of the construction site for later use on bare areas for dust or erosion control, or camouflage. Frequently, excavated muck may be kept for mixing with the upper layer of soil on shoulders and embankments to provide the humus necessary to support the growth of grass. As you may know, muck is a very soft, slimy silt or organic silt which is often found on the bottom of lakes or rivers.

If stripped material is not to be saved for future needs, it may be used for such purposes as widening embankment slopes, and improving the general level or contour of the ground in the vicinity of the construction site.



45.85(45B)
Figure 6-6. — Varieties of sumac leaves.

DITCHING

The excavation of ditches or trenches often is necessary to ensure proper drainage of the area during the period of construction. Adequate drainage will help prevent costly delays in operations caused by equipment bogging down. On many construction projects, you may see diversion ditches and outfall ditches used for drainage purposes. Diversion ditches are used to concentrate all surface water into natural channels. Outfall ditches are used to drain low or swampy spots.

Ditches or trenches also are needed in establishing a system of permanent drainage of subsurface water. One method of subsurface drainage involves a system of subsurface drain pipes placed in trenches with a backfill of suitable filter material. Another method is the use of a system of open ditches or channels; these may be new ditches or improved existing ditches.

Ditches or trenches may be dug with ditchers. Other types of equipment also can be used; for instance, dozers, scrapers, power shovels, and draglines. The type of equipment selected depends largely upon the size of the ditch or trench to be excavated, working conditions, and equipment available.

GRADING AND EXCAVATING

After some sort of a drainage system has been established, the grading and excavating of a construction area begin. GRADING involves shaping the ground to the desired form and height (technically called grade or subgrade elevation). EXCAVATING involves removing the soil from a proposed location for a structure or digging trenches for underground utilities, or drainage and irrigation systems.

Grade and Subgrade

Two terms associated with grading and excavating are "grade" and "subgrade."

GRADE is defined as the finished surface (pavements) or finished floor (buildings) elevation. SUBGRADE is the surface of natural or

stabilized soil on which a pavement or foundation rests. On most projects, subgrade elevation equals grade elevation minus pavement thicknesses. When grading and excavating are performed only to reshape the land and construction is involved, grade will be the surface elevation of the reshaped soil. Landscaping is an example of this type of work.

Cut and Fill

The operation of CUT and FILL consists of cutting the high spots to grade and filling in the low spots. In cutting down the high spots, enough suitable material may be removed to fill in the low spots. When there is not enough material to fill the low spots or embankments, material may be obtained from another location or from pits especially opened to obtain fill. Such pits are called BORROW pits.

Borrow pits are the source of select soil other than sand and gravel used for embankments, fills, or subgrades, and for mixing with existing soil for stabilization. SOIL STABILIZATION is the process of adding other types of material to the existing soil and compacting it in order to increase its load bearing capacity. When the construction site is always muddy or when it is swampy, stabilization is attained by driving piles into the ground. The piles may be made of wood, concrete, or steel. Generally, wooden piles are used. The piles provide a means of bringing the soil particles closer together, thus preventing the sinking or settling caused by the superimposed load (such as a bridge, building, pier or other structure) on the soil.

Scrapers and crawler-type tractors are generally used for cutting and filling on a grading site. When it is necessary to make long hauls, motorized scrapers and trucks are commonly used. Dozers are ideal for cutting and filling if the dirt does not have to be moved more than 300 feet; a dozer is also a good piece of equipment for backfilling ditches and culverts.

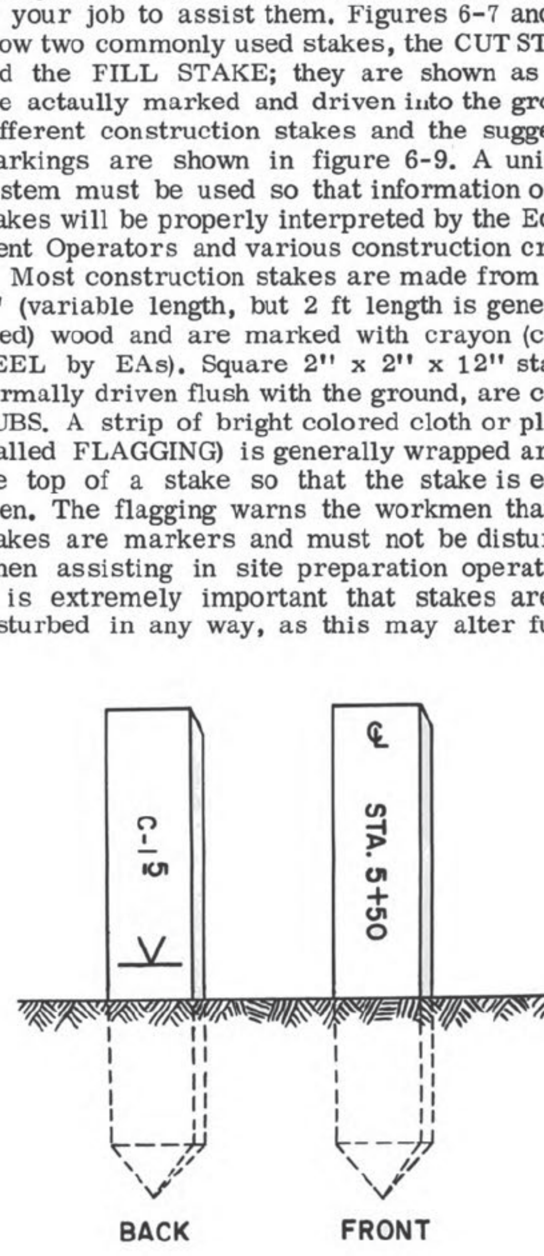
In general, fills are built up in compacted layers called LIFTS. Lifts vary in thickness, depending upon the compaction necessary and the material used for the fill. In constructing a fill, each lift is spread either by dozer or scraper and then compacted. (See the section on compacting material.) After each lift is compacted, the next layer is spread and compacted. Fill material must have the right moisture content before it can be compacted; therefore, it is sometimes necessary to wet the fill before it is compacted.

Construction Stakes

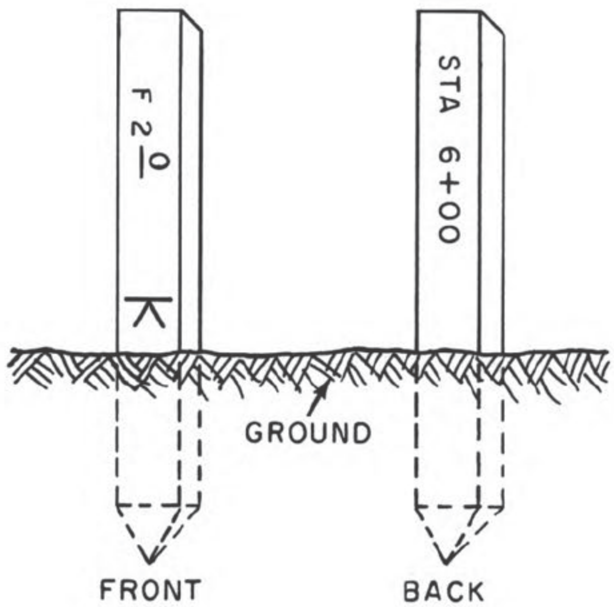
Construction stakes are markers used as guides in earthwork operations to indicate the extent of work, grade elevations, and structure locations. Construction stakes are used extensively in the construction of roads and buildings.

Setting out (called staking out) construction stakes is the job of men in the Engineering Aid rating; however, as a Constructionman, it may be your job to assist them. Figures 6-7 and 6-8 show two commonly used stakes, the CUT STAKE and the FILL STAKE; they are shown as they are actaully marked and driven into the ground. Different construction stakes and the suggested markings are shown in figure 6-9. A uniform system must be used so that information on the stakes will be properly interpreted by the Equipment Operators and various construction crews.

Most construction stakes are made from 1" x 2" (variable length, but 2 ft length is generally used) wood and are marked with crayon (called KEEL by EAs). Square 2" x 2" x 12" stakes, normally driven flush with the ground, are called HUBS. A strip of bright colored cloth or plastic (called FLAGGING) is generally wrapped around the top of a stake so that the stake is easily seen. The flagging warns the workmen that the stakes are markers and must not be disturbed. When assisting in site preparation operations, it is extremely important that stakes are not disturbed in any way, as this may alter future



29.79
Figure 6-7. — Cut stake.



29.80(45B)
Figure 6-8.—Fill stake.

operations. If stakes are inadvertently moved, notify your crew leader.

Excavating by Hand

There are occasions when machine excavation cannot be employed; for example, in places very close to existing structures which allow no room for the machine, or where very careful digging is necessary to prevent damage to existing underground utilities such as gaslines, waterlines, electrical conduits, and the like. These conditions require manual excavation.

Depending on the construction crew to which you are assigned, the excavations you do will be in connection with the facilities the crew will be putting in. The size and depth of excavation will depend upon the type of facility to be installed. If you are assisting the BUs, these excavations may be used for foundations or footings of buildings, headwalls, and wingwalls for bridge abutments and similar structures. When working with the UTs, your excavations may be for waterlines, sewerlines, manholes, and other utilities. When working with the CEs, your excavations may be for electrical conduits, electrical manholes, and poleholes. The digging procedures are basically the same, using ordinary digging handtools such as picks, shovels, and polehole diggers. Your main concern should be the observance of the proper safety precautions. Make sure you have enough room when you start using digging tools. Watch out for your fellow crewmembers. Watch that pick! It makes a neat hole in a foot, hand, or head.

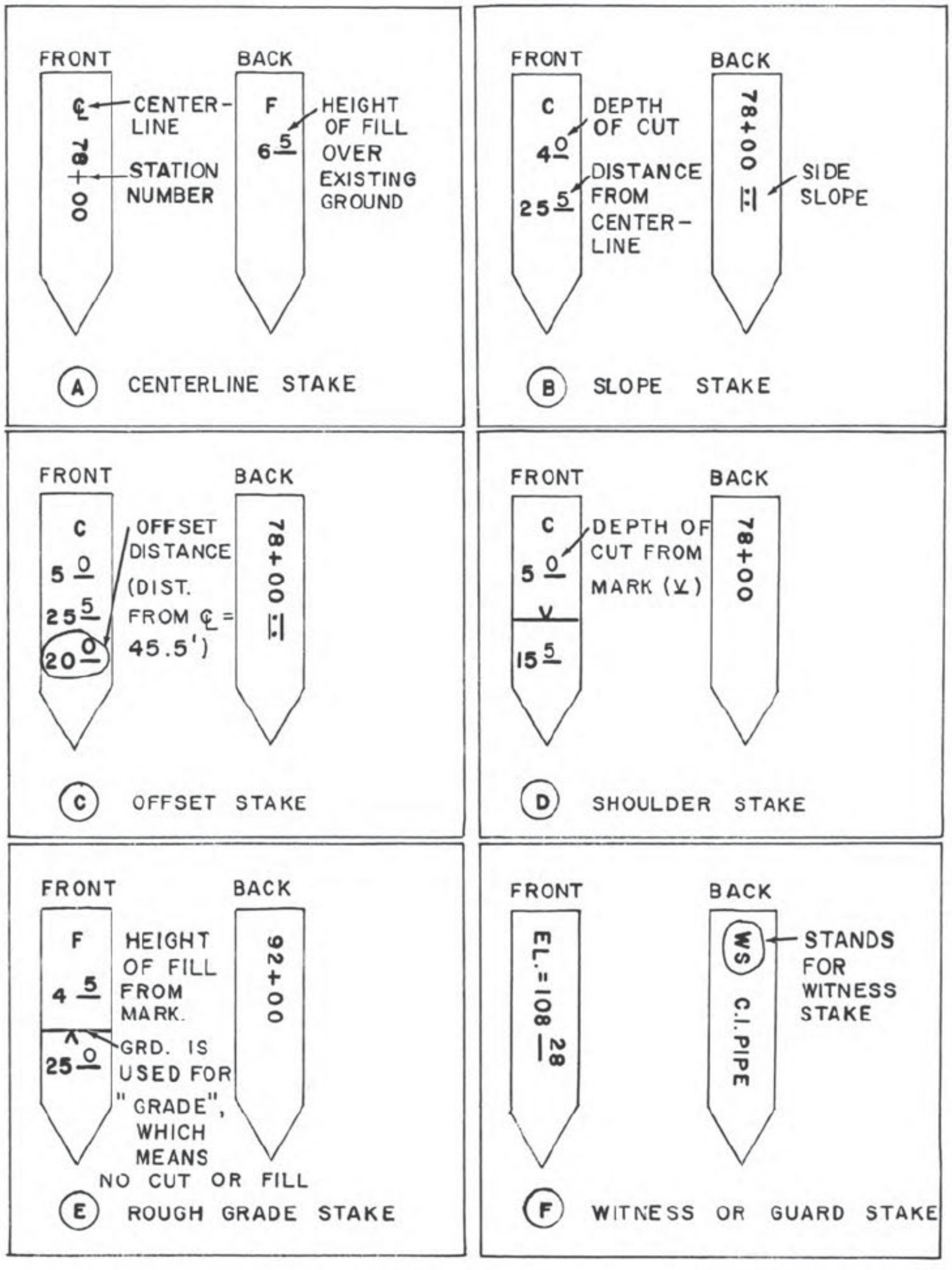
When the excavation is about 4 feet deep, and depending upon the type of soil, your crew leader may determine that shorings are required to prevent cave-ins. You will assist him in installing the shorings, braces, and other supports. Perhaps you have heard of men getting buried alive, or of men suffocating due to pressure on the body, even when their heads and shoulders were exposed during a cave-in. Cave-ins account for a great number of fatal accidents in the construction trade. Watch out for side cracks and loose rocks during excavation. Cracks are signs of weakness which may cause cave-ins, and loose rocks must be removed before they fall. Do not place tools or equipment and other materials at the edge of the excavation. Wear hard hats, gloves, and safety shoes. Do not jump; use a ladder. Water should not be permitted to accumulate in the hole.

Excavation in paved areas may require you to operate a PNEUMATIC HAMMER, commonly called a JACKHAMMER, to break the concrete or asphalt pavement. Jackhammers are also used to dig in dense soil or clay and for other purposes. Since you might be using this machine, you should be familiar with its capabilities and operating procedure.

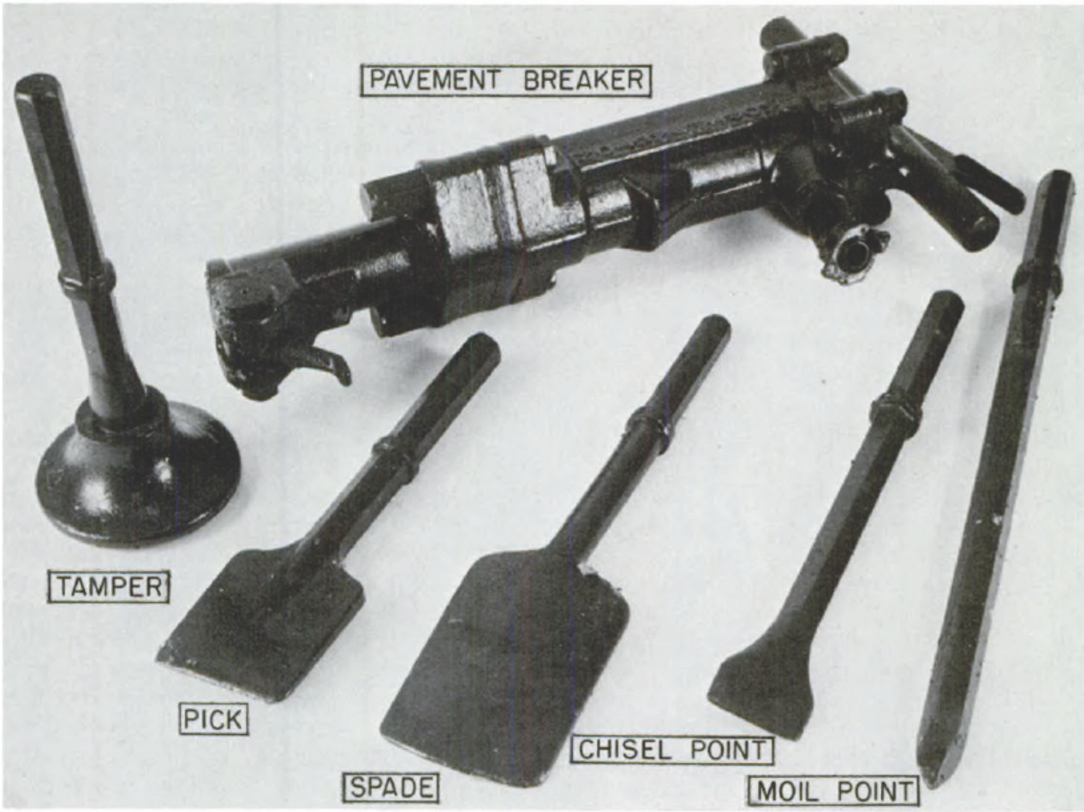
One type of jackhammer commonly used by the SEABEES is shown in figure 6-10. This type has a built-in air motor, powered by compressed air supplied by an air compressor. It uses the reciprocating percussion-type motor where hammering action is desired. The jackhammer is so constructed that it may be separated into three major groups of parts: the back head group, the cylinder group, and the front head group. These groups are joined together and secured by two side rod bolts. The BACK HEAD GROUP contains the air controls, oil reservoir, and operating handle. The CYLINDER GROUP consists of the piston, cylinder, and automatic valve assembly. The FRONT HEAD GROUP holds the tool attachment.

Three attachments are generally used; they are the MOIL POINT, CHISEL POINT, and TAMPER (fig. 6-10).

The moil point is a breaking device, which is used when breaking through concrete, stone or material of a similar abrasive character or density.



29.80(29E)
Figure 6-9.—Markings of different construction stakes.



127.267
Figure 6-10. — The jackhammer and its tool attachments.

The chisel point is used to cut asphalt, frozen ground, or extremely hard earth.

The tamper is used to compact loose material such as backfill to pipelines, foundations, and similar structures.

Other attachments such as the spade and the pick may be added to the three mentioned above. The spade, shaped like a garden spade, is used for digging trenches and excavations for footings or foundations, and doing any general digging too difficult and slow for an ordinary hand spade. The pick, which is shaped like the spade, but smaller, is generally used for digging into frozen ground, compacted gravel, or other material too hard to be penetrated by the spade.

Hold the jackhammer down while it is in operation, but use only sufficient pressure to guide the tool and keep it in place. Leaning heavily on the jackhammer will only shorten the stroke of the tool attachment and result in less work being performed.

It is of prime importance that the shank of each jackhammer attachment be the correct size. Improper shank sizes will reduce the effectiveness of the blow and cause damage to the jackhammer. It is equally important that the points of the attachments be kept sharp at all times.

In breaking work, only small bites (4 to 8 inches behind the working face) should be taken at a time. If a moil point becomes stuck, use the second breaker to dislodge the material binding the point. When the breaker is being used singly and the point becomes stuck, take the jackhammer off and use another point to free the stuck point.

Inspect the jackhammer parts from time to time to make sure that all nuts are tight. The airhose connections should be checked frequently to avoid escape of air. To ensure lubrication of moving parts, the oil level in the reservoir must be checked from time to time and oil added when low.

Keep the work area clear of broken material so that it does not interfere with efficient operation of the tool.

Wear goggles to protect the eyes from pavement chips and dust. Gloves and safety shoes are also required.

Never lay down the hammer in such a position that it may do some harm if the switch is accidentally tripped. Do not leave it in a standing position. Shut off the exhaust pressure from the line before disconnecting the line from the jackhammer.

Compacting Material

After the preliminary cutting and filling have been completed, it is necessary on projects such as road and airfield construction that the area be brought to final grade by motorized graders. Further smoothing and compacting are obtained by using smooth rollers. You will recall that various types of rollers used for compaction purposes were discussed earlier.

Compaction, as used in earthwork operations, means pressing together soil particles to form a firm mass. Compaction helps the soil to shed rainwater. It also prevents excessive evaporation, thus keeping the soil from becoming too dry. A main objective in compaction is to obtain a soil surface hard and firm enough to support loads without settling or buckling. Soggy surfaces indicate the presence of excess moisture, while uneven, lumpy surfaces indicate too little moisture.

THE ROLE OF THE CN IN EARTHWORK OPERATIONS

The Constructionman's duties in earthwork may not be exactly the same at one naval activity as at another. For that reason, a list of specific duties which would apply to Constructionmen at each activity cannot be spelled out in detail in this discussion. No doubt you probably have been wondering just how the CN fits into the earthwork picture. Let us take a brief look at several of the more common types of basic operations which may be assigned you when working on earthwork projects at various activities.

Felling Trees by Hand

At times you may be called upon to assist a team in felling trees by hand. The use of hand methods of tree removal or other clearing operations may be desirable for very small projects and for other jobs where equipment is not readily available or where breakdowns have occurred.

A two-man crosscut saw and single-bit ax frequently are used in cutting down trees by hand. The crosscut saw is especially useful with large trees (fig. 6-11). You are perhaps aware that power-driven tools, such as the chain saw, are excellent devices for felling any size tree — large or small.

Generally, when a tree is to be felled, the team leader will indicate the direction of fall by marking where the UNDERCUT is to be made. You would then start the felling by making the "V" type undercut as shown in figure 6-12. Note that the undercut forms an angle of 45° and that it is carried to the approximate center of the tree. When this cut is finished the back of the cut should be a straight line perpendicular to the direction of fall as illustrated in figure 6-13.

Next the BACKCUT is made. Move to the opposite side and cut through the trunk at a point approximately 2 inches above the undercut. The backcut should be kept parallel to the undercut until 2 or 3 inches of holding wood remain. If you are sawing, and the tree has not

29.82

Figure 6-11. — Using a crosscut saw to fell large tree.

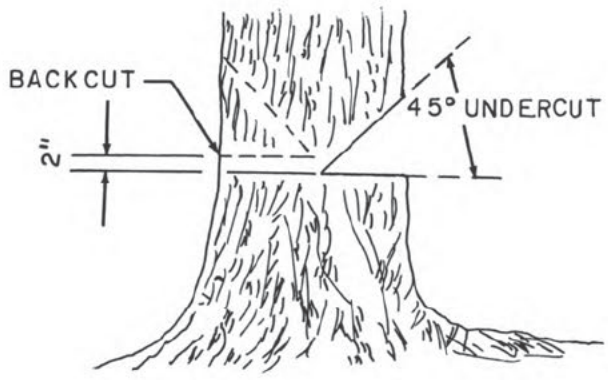


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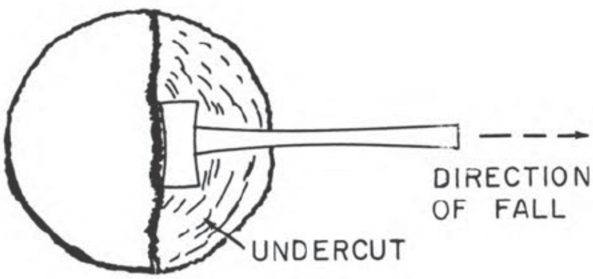
Figure 6-12.—How to make the undercut and backcut.



29.408
Figure 6-13.—Using a double-bit ax to test direction of fall.

yet begun to fall, it may be necessary to use wedges in order to continue. Do not saw less than 1 inch of holding wood. This is needed to serve as a HINGE that will guide the tree as it falls. Persons in the danger areas should be warned prior to the felling of a tree. A loud warning call, "TIMBER," should be given at the time of the felling of each tree. For your own safety, also, make sure you always look over the area carefully before starting to fell a tree and note mentally the existing avenues of escape—just in case something should go wrong. As a further safety precaution, remember that before felled trees are limbed, they should be properly secured by chocking or other means to prevent them from rolling.

In addition to the safety precautions given above, the following must be observed:

1. Check for rotten or dead limbs which might fall prematurely.
2. Check for rotten trunks which might cause the tree to fall unexpectedly.
3. Feller should move back and to one side of his sawing position (preferably behind another tree) and carefully watch the tree fall.
4. Never get directly behind a falling tree as it may kick back, particularly if the falling path is obstructed by branches of other trees.
5. Wear hard hats.
6. Never leave a tree partly cut.
7. If a tree becomes lodged in another, get instructions from supervisor on what to do.
8. When cutting on slopes, trees are apt to roll down. Always get above and cut the tree to fall diagonally along the hillside.
9. Keep alert to other crews in the area.

When felling is done with a crosscut saw, remember that you must ALWAYS PULL, NEVER PUSH, with the two-man saw. Sap from a green tree often gums the blade and makes the cutting difficult and the pulling of the saw harder. When this happens, sprinkle kerosene on the saw blade to clean and lubricate it. In many cases, the saw also will start dragging as the cut progresses into the trunk towards the undercut. This calls for the use of wedges, which are driven into the kerf (cut) with a maul or other suitable device. The wedges spread the kerf so that the saw can be pulled more easily with little or no dragging. Wedging may be required to fell a leaning or unbalanced tree in the desired direction. This technique is not for novices.

When the felling is done with a chain saw, the following safety precautions must be observed:

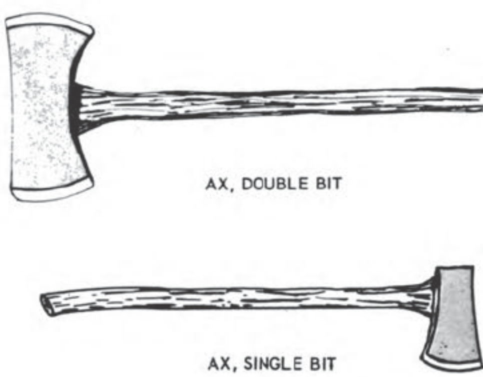
1. Do not attempt to start the chain saw by holding it with one hand and pulling the starter with the other hand.
2. Always have a firm footing during operation.
3. Saws get hot. Don't touch hot parts with bare hands. Use gloves.
4. Never test tension of a chain when the engine is running.
5. Do not move the saw from one tree to another while it is running.
6. Don't smoke when refueling gasoline engine-driven chain saws. Use a gas can with spout or funnel.
7. Don't start the engine where the tank was filled or near the gas can.
8. Keep the saw clean of gasoline and sawdust.
9. Keep a fire extinguisher handy when using the chain saw and when refueling.

Using Axes

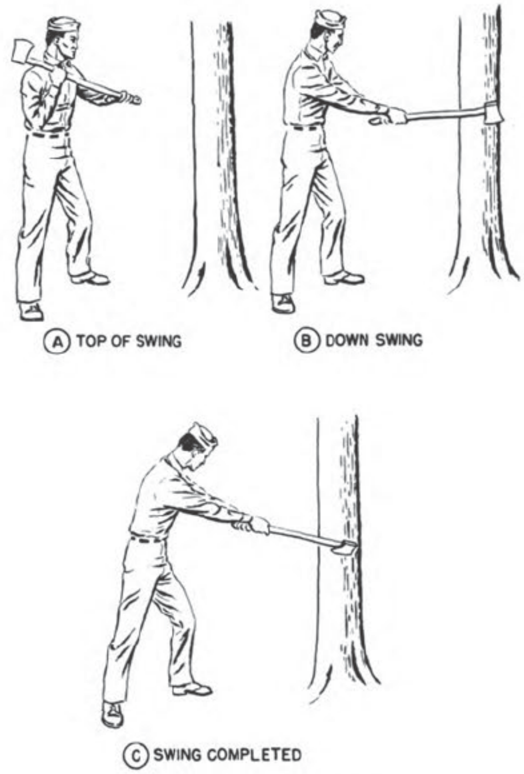
You may use an ax not only for felling trees, but for other purposes such as trimming trees, cutting logs into convenient lengths, clearing brush, and splitting and cutting wood. A number of different types of axes are available, two of which are the single bit (or single-edge) ax and the double bit (or double-edge) ax, both shown in figure 6-14.

Before using an ax for chopping, make sure that you have room for a complete unobstructed, free swing of the ax, particularly overhead. Make sure you have a firm footing to prevent the ax from glancing and striking the body if the mark is missed. For best results in chopping with the ax, stand so that the body weight is distributed equally on both legs; have the knees set but not tense and spread the feet apart a comfortable distance. The body should be relaxed and free to swing and bend frm the hips. If you are a right-handed person, you should find the following method of using an ax very satisfactory. To start the swing, hold the handle at the end with your left hand and near the center with your right hand. For cutting a tree, bring the ax over the shoulder as shown at A, figure 6-15. Then swing the ax towards the target, and while doing so, slide the right hand back along the handle towards the left hand. (See B, fig. 6-15.) In this procedure, the hands should be close together at the finish of the swing, as indicated in C, figure 6-15.

If you are a left-handed person, your left hand should lead on the ax handle when using the ax. When cutting a tree, you should swing the ax in the same manner as described above for a right-handed person, except that the positions are reversed.



29.83
Figure 6-14. — Axes.



29.84
Figure 6-15. — Using an ax.

When using an ax, it is important that you check frequently to see that the handle is tight and has no splits or breaks in the wood. To have a loose head fly off during a swing might cause serious injury to yourself or a coworker. Before swinging an ax, always make sure no one is close enough to be endangered by the swing or by a possible glancing blow of the tool. Very few people are cut seriously with a sharp ax. It is the dull ax which strikes a glancing blow that causes most injuries. Remember that axes are chopping tools; therefore, they should NOT be used as wedges or mauls. A double-bit ax should never be driven into a stump or log when not in use. Someone moving or tripping against it could be cut accidentally.

Hand-Loading Logs

After trees have been felled and trimmed, those that can be made into timber or used for

other worthwhile purposes generally are removed from the construction site by truck. Cranes can be used to load the logs onto trucks. Or, a dozer may be used with logging chains to skid the logs up onto the truck. When equipment is not available, though, the CN may be assigned to a crew for loading the logs by hand. Various labor-saving devices which will give the greatest mechanical advantage must be utilized. You will find the cant hook a very handy device in hand-loading of logs. (See illustration of a cant hook in chapter 11.) Cant hooks provide good leverage, thus aiding the moving operation. Other devices that may be used in loading operations are block and tackle, jacks, rollers and winches.

Care must be exercised when handling heavy logs or timbers to prevent crushing anyone. As a safeguard, no one should be permitted to stand between logs being handled and other logs or heavy objects. Do not stand near taut cables since there is danger of backlash in case a cable should break. Loose garments must not be worn when working around winches. Wear safety shoes, gloves, and hard hats.

Burning

In clearing an area for new construction, stumps and brush may have to be removed from the site. But this material and other debris may often be disposed of at the site by burning. Too strong emphasis cannot be placed upon the need to know and follow safe practices in burning materials.

In case you are assigned to a burn detail, remember that burning operations must be kept under strict control and not left unattended. They should always be conducted in the clear, where the fire will not ignite leaves, dry wooded areas, or nearby buildings. Workmen should not stand in the smoke. All burning or smoldering material must be COMPLETELY EXTINGUISHED before workmen leave the scene.

Firing, punching, and placing of material for burning should be done from the windward side. AVOID THE SMOKE FROM BURNING POISON OAK, POISON SUMAC, OR POISON IVY AS IT IS HIGHLY TOXIC. Flammable liquids should NEVER be used on material which is burning or smoldering.

CARE OF HANDTOOLS

When handtools are used on earthwork projects, the CN will probably be responsible for their storage and care. Before storing any type of handtool, it is important that you check to ensure that it is clean and in serviceable condition. With axes, for instance, check to make sure the cutting edge is sharp and free of nicks, and that the handle is tight and free of splits and splinters; if these or other defects are found, have the tool repaired before putting it away.

Remember to store all sharp tools, such as axes, so that the cutting edge cannot injure any one. These tools should be stored so that the cutting edges will not be stuck against metal or other hard surfaces which might dull or nick the edges. Place axes on their heads or hang them on a rack. The edge can be further protected by a leather sheath.

If axes are to be stored for a short time only, clean them thoroughly and coat the metal surfaces with a light oil before putting away. For long term storage, coat the metal surface (after cleaning) with a rust-preventive compound rather than oil; store in a dry place, in racks or boxes, with the cutting edges properly protected.

QUARRIES

The Equipment Operator is responsible for operating equipment such as bulldozers, shovels, and dump trucks which are used in moving and handling quarry materials. He will also work with rock crushers and similar equipment used to process rock materials and get them ready for use as aggregate on construction jobs. The CN will work along with the EO in loading, hauling, and processing materials obtained from quarries.

A QUARRY is a site from which rock is obtained for use in construction. There are two common types of quarries — hard rock and soft rock.

The material in a HARD ROCK QUARRY can only be obtained by drilling and blasting. This material (granite, limestone, sandstone, or such) is highly desirable for processing into aggregate. This processing of stone into aggregate generally consists of crushing and screening the quarried material. The screening is accomplished by moving the crushed stone over a series of screens, each with a smaller mesh than the prior screen, to segregate the material according to size. In road construction the coarser aggregate is commonly used as base material and the finer aggregate is used as surfacing material. Too, aggregate

is desirable for use in both concrete and bituminous mixes.

The material in a SOFT ROCK QUARRY is soft enough to be loosened with a rooter. The material can be moved with scrapers or bulldozers, and loaded with power shovels. Materials obtained from soft rock quarries include soft coral, caliche, and tuff. Such materials ordinarily have cementing qualities which are provided by adding water. Materials obtained from soft rock quarries often are used for base courses and surfacing. They are suitable for use in airfield construction— and sometimes are used in road construction. Lumpy material undergoes further processing on road or runway surfaces by use of grid or tandem rollers.

QUARRY EQUIPMENT

Various types of equipment are used in quarry operations. Types commonly used in hard rock quarries include bulldozers, drills, blasting machines, power shovels, and miscellaneous handtools. A typical quarry layout is shown in figure 6-16.

The BULLDOZER is an efficient piece of equipment for pushing blasted rock into piles for loading, clearing the quarry floor, and maintaining haul roads.

A DRILL is used for drilling boreholes in the hard rock materials. The boreholes are loaded with explosive of sufficient strength to break the rock materials into pieces when fired. Different types of drills are commonly used in quarry work. One of these is the CRAWLER-MOUNTED DRILL. It is shown in figure 6-17, with the compressor (its power source) in the foreground. The crawler-mounted drill is a part of the rock drilling and blasting component, which includes all items of equipment needed to drill and blast, except for the explosives. The crawler drill is a self-propelled unit designed primarily to drill vertical and angular blast holes in rock. The track mounting gives this drill good on-the-job mobility, as well as excellent drilling stability on difficult terrain.

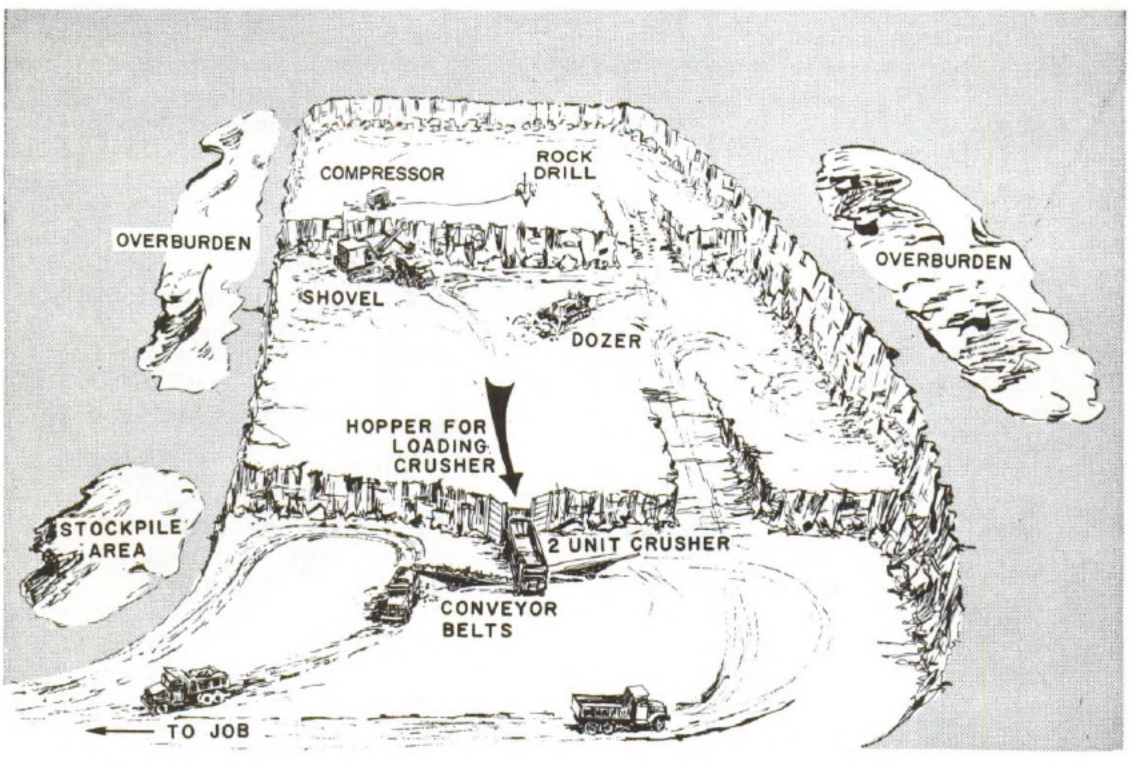


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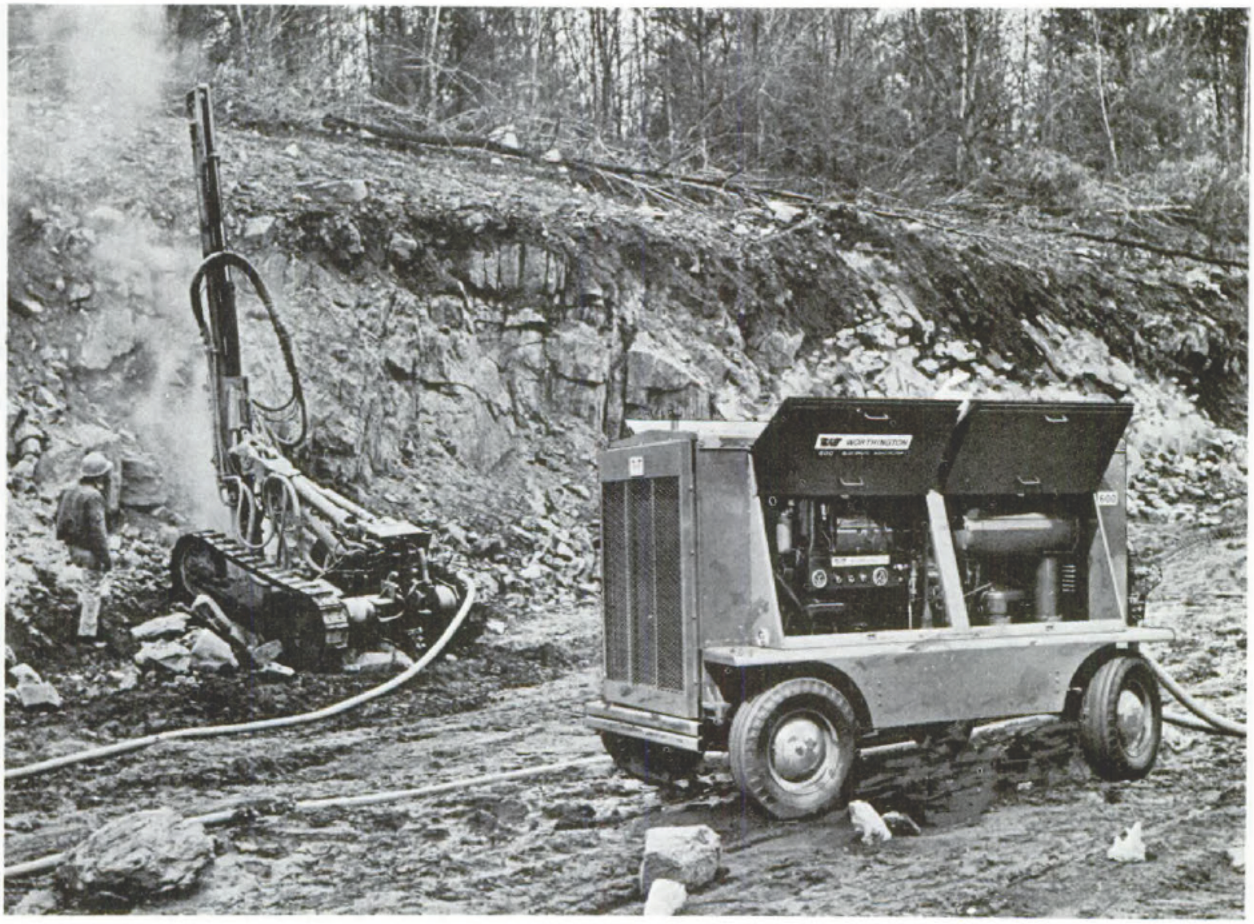
Figure 6-16. — Typical quarry layout.



29.216X
Figure 6-17. — Compressor and rock drill on the job.

There are several makes and models used by the Construction Force.

The crawler drill is composed of two basic assemblies — the carrier unit and the drill unit.

The CARRIER consists of two crawler tracks, each powered by a separate air motor. The tracks may be either all steel or rubber padded, 10 to 12 inches wide. They are driven by the air motors through a gear train that includes forward, reverse, and neutral. Each track has its own brake. The crawler drill is turned by locking or reversing one track while moving the other forward. The crawler drill can tow a 600-cfm air compressor on the jobsite. The compressor feeds the drill through a 2-inch airhose. The operator's controls are grouped at the rear of the crawler drill. These controls allow him to "drive" the crawler unit or manipulate the drill itself. Some crawler drill models have a seat or a standing platform for the operator's use during travel; others require him to walk behind the unit as it moves.

The DRILL UNIT is connected to the carrier by a hydraulic boom assembly. Movements of the boom are controlled by two hydraulic units; one for lift, one for swing. This facility allows a variety of drilling positions regardless of the crawler's mounting alignment. The drill frame is made of two 6-inch steel channels, between which runs a 1-inch chain. The chain moves the drill up or down the channel assembly. The drill is of the piston type which rotates the steel slightly after each blow. Crawler drills have forward, neutral, and reverse rotational

ability since the drill steels have threaded couplings on each end. These threaded steels allow simple addition, rather than replacement, of new steels as the drill hole deepens.

The POWER SHOVEL is a familiar object at quarry sites. It is useful for loading blasted rock into dump trucks and for loading crushed aggregate from stockpiles. Dump trucks haul the broken rock from the quarry to a crusher (or a crushing and screening plant). After the rock has been properly crushed and prepared for use, it then is loaded onto dump trucks which haul it to the construction job.

In the absence of a power shovel, a LOADING RAMP may be constructed for loading the quarried rocks into dump trucks with the use of a dozer. The simplest type of loading ramp is shown in figure 6-18. Depending upon the size of the project, a more complicated loading ramp with provision for traps and gates may be constructed.

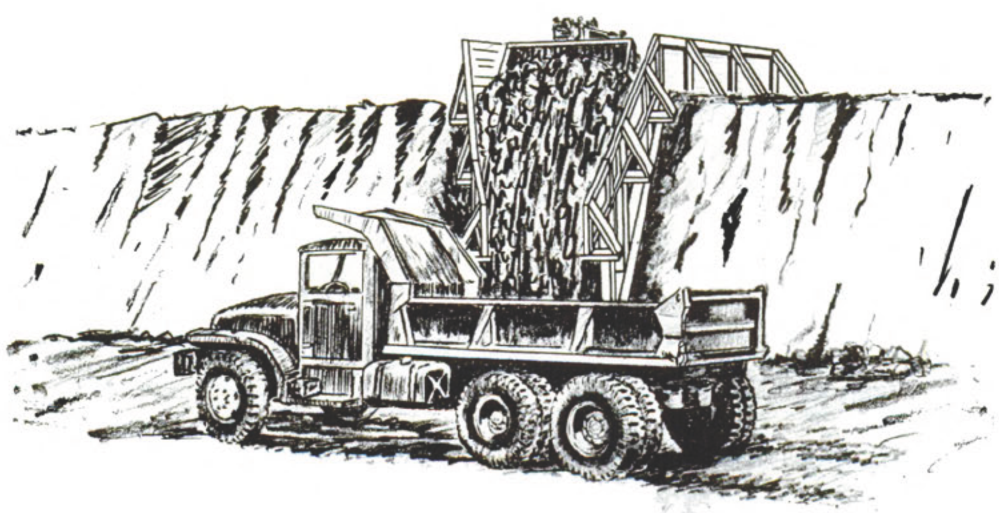
A good variety of HANDTOOLS generally are available for use at a quarry; examples of these tools, to mention a few, are shovels, crowbars, axes, picks, stone hammers, and stone wedges. Among other types of equipment generally available are conveyors for stockpiling and bins for storing aggregate.

BLASTING

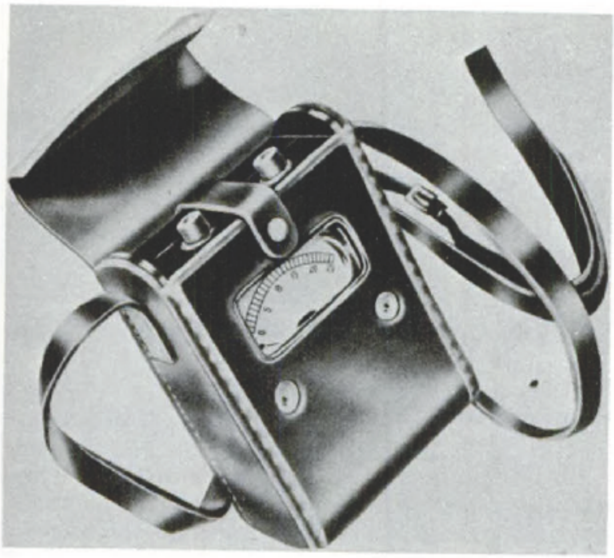
In quarry work, blasting provides a quick and effective means of breaking up large rock formations. As mentioned earlier, blasting may also be used for different purposes in construction site preparation; such as, for breaking the roots of large trees so they can be pushed over by a dozer, or for breaking up large rocks or other hard materials during construction of drainage facilities. Only qualified blasters are allowed to perform blasting operations.

After drilling, the boreholes are cleaned out and loaded with the required explosives. Then the explosives are wired. All connections are tested to make sure that no loose connection is present and the circuit is complete.

An instrument commonly used for testing is the blasting GALVANOMETER (fig. 6-19). This instrument is used to test individual electric blasting caps, to determine if the circuit is ready to fire, and to locate faults, shorts, and grounds.



115.351
Figure 6-18.—Simple chute loading ramp.

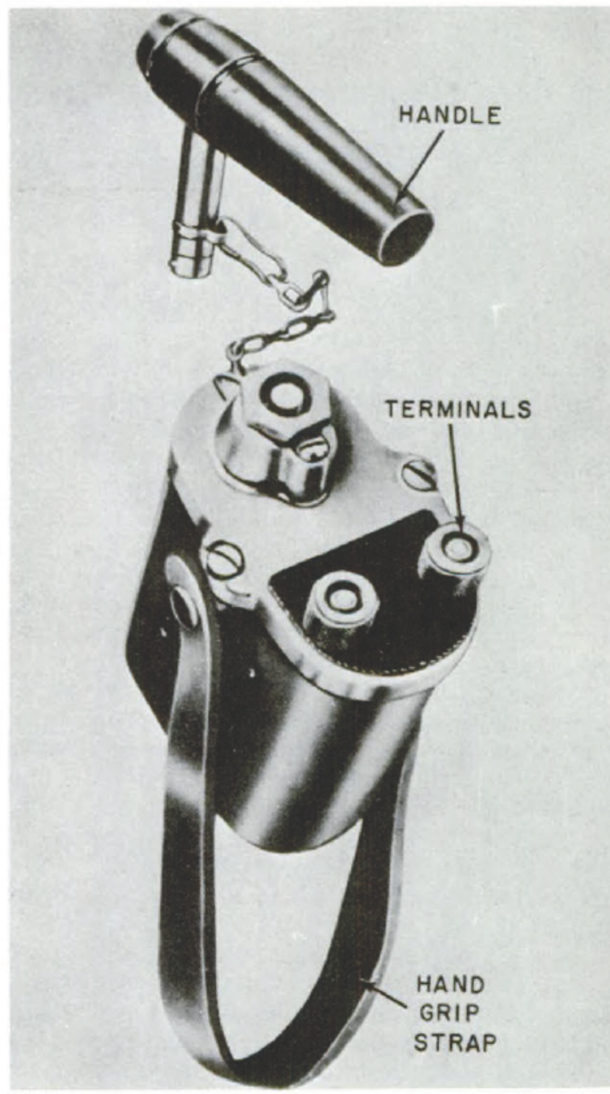


29.88
Figure 6-19. — Galvanometer.

The BLASTING MACHINE (fig. 6-20) is the source of electric current which triggers the electrically fired blasts. A small pocket-size blasting machine is available. It is very likely, however, that the machine often will be a small portable dynamo in which the armature is rotated by the downward thrust of the rack bar to convert mechanical energy into electrical energy. Blasting machines range from 10-cap capacity to 50-cap capacity.

Blasting is a specialty and it is hazardous work. As a Constructionman, you will probably have very little — if anything at all — to do with actual blasting operations. It is not necessary, therefore, that you have a detailed knowledge of explosives, methods of blasting, operation of blasting equipment, and so on. Sometimes, however, you may work as a helper with a blasting crew. So, for your own PERSONAL SAFETY, it is very important that you know at least a few of the major precautions applicable to blasting.

All handling of blasting equipment will be supervised by an experienced blaster. Boxes containing explosives must be handled with special care. It is important, also, that only the proper tools be used to open boxes of explosives. Consult your supervisor before you start opening these boxes.



29.87
Figure 6-20. — A 10-cap blasting machine.

No smoking will be permitted when handling explosives or in areas where explosives are stored. Members of a blasting crew must not carry any matches or cigarette lighters.

CHAPTER 7

CARPENTRY AND PAINTING

In a broad sense, CARPENTRY, in the SEABEES, covers the construction, maintenance, and repair of all wooden structures; these range from light frame structures such as barracks and messhalls to heavy structures such as bridges, wharves, piers, and towers. It also includes fabricating and erecting forms for concrete; erecting scaffolds and catwalks; and fitting and installing windows, doors, and cabinets.

As a Constructionman, you are not expected to be an expert carpenter, as this is the responsibility of the Builders and Builder strikers. However, it is probable that you will serve as a helper on projects where wooden structures are being built or repaired. You may also find yourself assigned to the carpenter shop as a helper where you will assist in various fabrication, assembly, and repair operations.

Also as a Constructionman, you will be expected to have a basic knowledge of PAINTING and you will be required to assist experienced painters in various painting operations.

In most of your assignments, you can expect to spend much of your time doing such basic jobs as handling and storing materials, cleaning and maintaining tools and equipment, and other general housekeeping tasks. A major objective of this chapter, therefore, is to acquaint you with the safety precautions to be observed in these operations and while performing other basic jobs in carpentry and painting.

Because of the importance of materials in construction, another objective of this chapter is to introduce you to some of the more common materials used in carpentry and painting—for instance, lumber, wallboards, insulation, roofing, hardware, paints, and preservatives.

You will also be introduced to basic handtools and portable power tools used by builders. Unless specifically authorized, you will not operate carpenter shop equipment. However, you must understand their purpose and safety precautions you will need as a Builder.

CARPENTRY MATERIALS

Lumber is the most commonly used carpentry material. There are many other materials, however, that are used in carpentry operations. In this section we will discuss some of these materials. Since lumber is of special importance, more details are given on lumber than on the other materials.

LUMBER

"Lumber" is a general term used to describe timber that has been sawn into specific shapes and sizes. As used here, TIMBER refers to logs which have been specifically cut for manufacturing lumber. As you will learn, the word "timber" is also used to describe certain lumber cut to large dimensions. Builders are required to know the common types and grades of lumber and the particular purpose for which each is suited. However, as a Constructionman, you are only required to understand common lumber terminology.

Classification of Lumber

All lumber is classified as either a HARDWOOD or a SOFTWOOD, depending upon the species of tree from which it was produced. It would be natural to assume that these terms refer to the degree of hardness in the wood, but this is not so. Some so called softwoods (fir, for example) are harder than many hardwoods. Actually, softwood and hardwood refers only to the types of trees from which the lumber was made. Wood from trees with cones and needles (called evergreens or conifers) is classified as "softwood." Pine, spruce, fir, and cedar are examples of softwood trees.

Wood from trees with broad leaves (such as maple, oak, walnut, and cherry) is classified as "hardwood." In general, woods from hardwood trees are harder than those from softwood trees,

but, as mentioned already, there are many exceptions.

Types of Lumber

Generally speaking, most lumber can be roughly classed as one of four basic types—these are BOARD, DIMENSION, TIMBER, and SHOP. In addition, other lumber is produced for a specific purpose and these are known by their use, such as siding, flooring, planking, and so on.

BOARD lumber is any lumber intended for general light construction that is less than 2 inches thick. Depending on its quality, it is used for such things as sheathing, sub-flooring, shelving, and occasionally trim.

DIMENSION lumber is also intended for general light construction, however, it is at least 2 inches but less than 5 inches thick. Dimension lumber is most generally used to build the frames of such structures as homes, garages, and other small buildings.

TIMBER lumber is any lumber 5 inches or greater in both thickness and width. Timbers are used in heavy construction to build bunkers, towers, bridges, and piers.

SHOP lumber, also called factory lumber, is high quality lumber intended to be cut up in sizes suitable for use in the manufacture of such items as doors, windows, and trim.

Size of Lumber

As a Constructionman, you will probably become most familiar with lumber in relation to its size. For example, you may be told to "get those 2 x 4s" or "use these 1 x 6s." Lumber size is always expressed in terms of THICKNESS (T") and WIDTH (W") in inches, and LENGTH (L') in feet—that is, T" x W" x L'. The times sign (x) is read "by" and you would say, 2 by 4 by 12, for example, the inches and feet being understood. It is important to know that lumber is always referred to by its NOMINAL SIZE rather than by its ACTUAL SIZE.

Nominal size refers to the cross section dimensions before the lumber was DRESSED (planed smooth). Of course, rough lumber (not dressed) has the same nominal and actual dimensions.

Lumber Grading

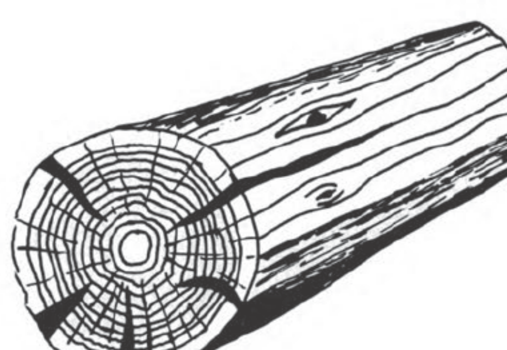
Grading lumber is a skill which requires many years of experience. In general, however, you should know that grading depends primarily upon the QUALITY of the wood and its intended USE. A typical log yields lumber of varying qualities, depending upon the number of defects and blemishes it may contain. A DEFECT is a flaw which impairs the strength or utility value of the lumber. On the other hand, a BLEMISH is a flaw which simply mars the appearance of the wood.

Some common and obvious defects in lumber are decay, holes, knots, splits, and checks. CHECKS are lengthwise grain separations that are caused by shrinkage (see fig. 7-1). STAINS are the most common natural blemish and they are usually caused by fungi or mineral deposits. KNOTS may be either a defect or blemish, depending upon the size and tightness. For example, a small knot may not adversely affect the strength of a member, however, its appearance may be objectionable—especially in cabinet work where a clear finish is specified. On the other hand, the same size knot would be a defect if it were loose, as it may fall out and leave a hole. Both blemishes and defects may be the result of improper sawing, dressing, and handling.

The better the quality of the lumber—that is, the fewer defects and blemishes—the better the GRADE. Therefore, your better grades of lumber are used where strength and appearance are important, and the poorer grades are used for such things as dunnage and crates, where strength and appearance are secondary.

Seasoning Lumber

Green (freshly cut) lumber contains considerable moisture—30 to 300 percent by weight.



29.115
Figure 7-1.—Checks due to shrinkage.

This moisture is removed by seasoning. Seasoning is done primarily to reduce weight and to increase strength. Other benefits are: reduced shrinkage and warpage while in service; increased resistance to decay and insect infestation; and a better capacity for holding paints and other preservatives.

Most lumber is seasoned either by AIR-DRYING or by KILN-DRYING. Air-dried lumber is seasoned naturally in the open air and it generally takes several months to reach the desired moisture content. For this reason, practically all commercial lumber if kiln-dried. In kiln-drying, the wood is placed in a tight enclosure and dried with artificial heat. For most species of wood used in general construction, kiln-drying takes only a few days.

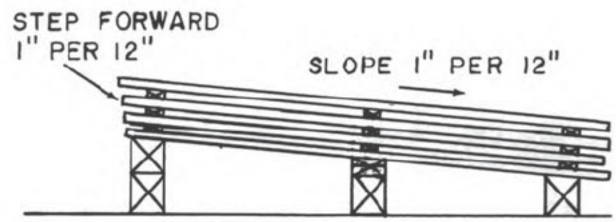
Handling and Storing Lumber

As a Constructionman, you will probably do your share of handling and storing lumber. This work is very important to the construction effort. Proper storage is necessary to ensure that the lumber is in good condition when ready for use.

Lumber is stacked or stored carefully to keep it dry and to prevent excessive shrinking, expanding, and warping. Different sizes of lumber are stacked individually for easy removal.

Good ventilation helps keep lumber dry. In addition to leaving small spaces between adjacent edges in the pile, ventilation is also provided by placing a number of small wooden spacers between each layer. These spacers are termed SCANTLINGS in the Navy, and it is important that they are placed directly over the supporting sills and one above the other in succeeding layers, as in figure 7-2. Normally kiln-dried lumber does not require spacing; however, when such lumber is piled higher than its base width, scantlings are used every so often to tie the pile together.

It is desirable, especially with the better grades, to store lumber under cover or indoors. This is generally impractical, so most lumber used by SEABEES is stored in the open. When lumber is stored outside, aisles are maintained between individual piles, and between piles and buildings, to prevent costly fires and to provide access for trucks and emergency vehicles. Lumber stored in the open is kept clear of the ground to prevent decay, and the pile is built up with a slight incline — about 1 inch per foot — to allow rainwater to flow off easily. Whenever possible, outside stacks are protected from bad weather by waterproof coverings.



29.116
Figure 7-2. — Correct storage arrangement for lumber.

You should observe the following rules and safety precautions when handling, storing, or otherwise working with lumber:

ALWAYS wear heavy leather gloves, and possibly aprons, to protect against splinters.

WEAR safety shoes when piling lumber and when working with timbers.

AVOID skin contact with lumber treated with "creosote."

LEARN where the first aid kit and fire-fighting equipment are kept for emergencies.

KEEP a hammer and bar handy to pull nails or open bundles of lumber.

BE careful of banded bundles of lumber. When these bands are broken, they may whip about and cause serious injuries. Also, the bundle may suddenly collapse.

BE aware of vehicles operating in your area, and be careful not to step out from behind stacked lumber into their path. If you are on the other end of a piece of lumber, don't push your buddy about.

DO NOT attempt to ride on materials handling equipment and keep your hands and body out from under loads.

WITHOUT specific instructions, lumber should not be piled over 16 feet high and the width should be at least one-quarter of the intended height.

LUMBER piles tend to harbor rodents and insects which, in turn, tend to draw snakes. When loading stacked or loose lumber, be cautious as you near the bottom of the pile.

WALLBOARD

"Wallboard" is a general term applied to a variety of manufactured sheet materials used to cover interior walls, partitions, and sometimes ceilings. In addition to its decorative value, wallboard adds stiffness to a structure

and it can be quickly installed, saving time and labor in construction.

Commonly used types of wallboard are gypsum board and fiberboard. GYPSUM BOARD is composed of gypsum between two layers of paper. FIBERBOARD is made of compressed wood or vegetable fibers. PLYWOOD is often used as a wallboard and it is composed of alternate layers of peeled wood glued together perpendicular to one another.

Certain types of wallboards, particularly plywood, can be used on outside walls as sheathing or to provide insulation against heat or cold.

MILLWORK

The term MILLWORK applies to mill or shop-made products such as kitchen cabinets, doors, windows, molding, and similar units which are installed at the same time as the interior is "trimmed out." These products are generally installed after the finish floor is laid. Incidentally, interior trim comprises a variety of millwork products.

Lumber used for millworking is your better grades, thoroughly seasoned, and generally straight grained and free of knots. Softwoods are generally used for painted items and hardwoods for items receiving natural or clear finishes.

INSULATION

Insulation often is a main factor deserving consideration in the construction of many kinds of buildings, especially dwellings. Proper insulation is necessary to ensure fuel economy and comfort in winter and in summer.

Varied types and forms of insulating materials are commercially produced. While each type has advantages for specific uses, no one type is best for all applications.

One type of insulation is "flexible" insulation, which comes in blanket or batt form. BLANKET insulation usually comes in rolls or strips in convenient lengths and widths to suit standard building practices. BATT insulation is furnished in similar widths but the individual batts are usually 2 or 4 feet long. Both types are made of wood or vegetable fiber, or of mineral wool, and both are available in paper covers.

Another common material is FILL INSULATION, which may be poured or blown into open spaces. This may be granular material or it may consist of small, detached clusters of fiber made of mineral wool. The use of fill insulation often is desirable over level ceilings below unheated attics. It can be used, also, inside walls of existing buildings that were not insulated at the time of construction.

Another type of insulation is RIGID insulation. This is a fiberboard material made from processed wood, sugarcane, or other vegetable products. These insulating boards come in large sheets of various sizes and finishes. In houses, these boards are frequently used for sheathing and as a plaster base for the inside surface of exterior walls and of ceilings. Rigid insulation can also be obtained in decorative units for insulating walls and ceilings.

Many insulation products cause eye, skin, and lung irritation, particularly those types made from minerals such as spun glass. Gloves, goggles, respirators, and tightly buttoned clothing should be worn in this type of work.

ROOFING MATERIALS

Roofs generally consist of two layers—a lower layer termed the ROOF SHEATHING, and an upper layer termed the ROOF COVERING (or ROOFING). Plywood, in 4 by 8 foot sheets, laid horizontally, is generally used for roof sheathing.

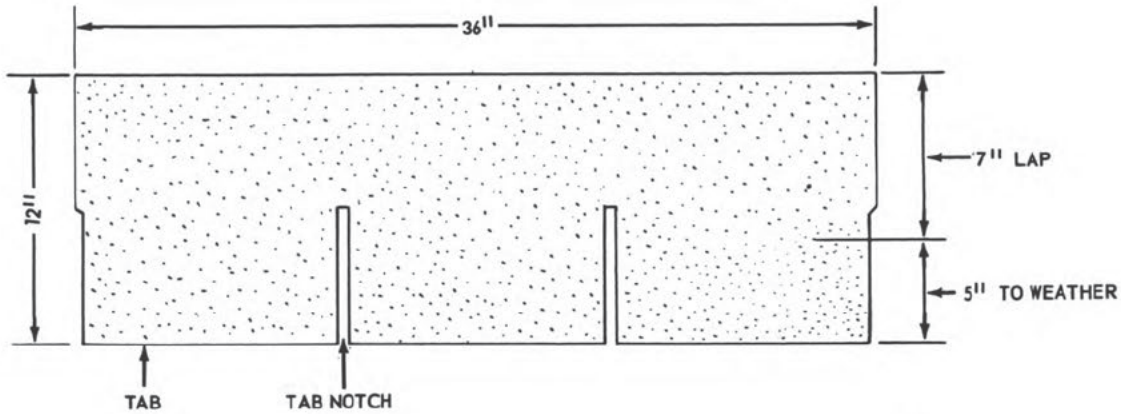
Some materials used as roof coverings are slate, wood shingles, asphalt, asbestos-cement, and so forth. On pitched-roof Navy-built structures, you will find that asphalt and asbestos-cement are the types of roof coverings frequently used.

ASPHALT ROOFING comes in rolls and in flat strips called STRIP SHINGLES. The type of asphalt shingle most commonly used is the 12 x 36 inch SQUARE-BUTT STRIP SHINGLE shown in figure 7-3. The lower end of a shingle which is exposed to the weather is called the BUTT; and the shingle shown in the figure has a square butt divided into three TABS.

When applying an asphalt strip shingle roof, an underlay of ROOFING FELT is first applied over the sheathing. Roofing felt is a heavy rag or asbestos paper that has been impregnated with a bituminous compound.

Asphalt roofing products become very brittle in cold weather and caution should be used when handling them to prevent unnecessary breakage. In very hot weather, care must be taken to avoid tearing asphalt roofing products or "scuffing" them with your boots.

There are two common types of ASBESTOS-CEMENT ROOFING products you will work with in the SEABEES. These are (1) small individual shingles and (2) large corrugated sheets. Care



29.120
Figure 7-3.—A 12 x 36 inch square-butt asphalt strip shingle.

must be taken when handling or fastening asbestos-cement products, as they are relatively brittle and easily cracked or broken. Most require pre-drilling before nailing or bolting.

Corrugated sheets are not normally placed over a solid roof sheathing. Instead they are commonly fastened to wood or steel PURLINS spaced a few feet apart. When working on this type of roof, you must always walk and keep your weight over these purlins.

On flat or nearly flat roofs, BUILT-UP ROOFING is generally applied. Built-up roofing consists of several layers (called PLIES) of roofing felt set in a hot "binder" of melted coal tar or asphalt. A final layer of binder is spread on the uppermost ply of felt; and this is commonly coated with a layer of gravel or slag to help prevent the binder from "running" in exceptionally hot weather.

Figure 7-4 shows a typical 5-ply built-up roof. Note how the widths at the starting edge of the roof are varied so as to get 5-ply coverage, with 10 inches to the weather, all the way up the roof.

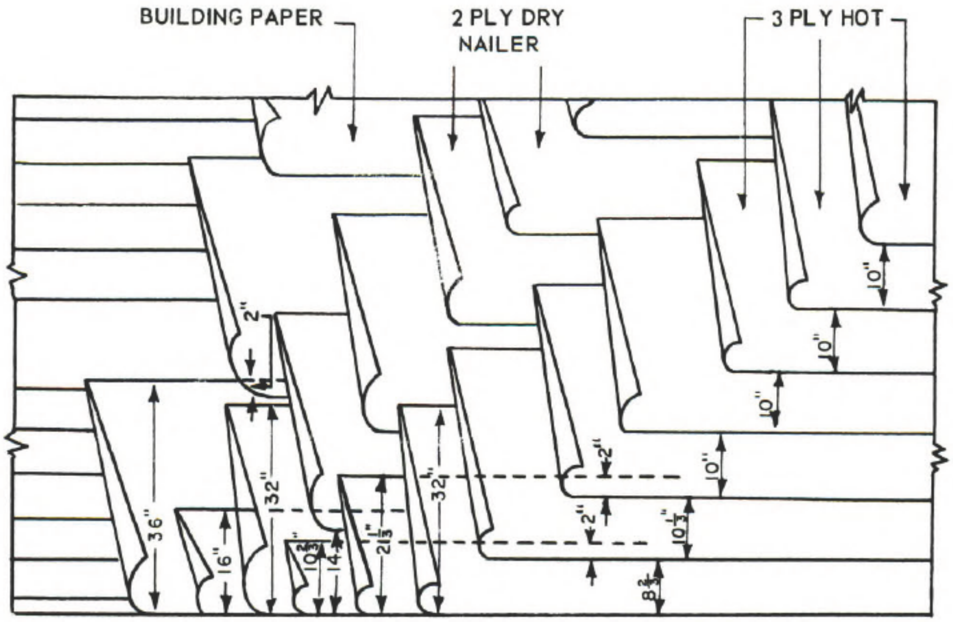
The binder for built-up roofs is usually heated in a "kettle" by kerosene burners. If you are assigned to work on a built-up roofing crew, be sure you are familiar with all the safety precautions. Most important to remember is that absolutely NO WATER should be allowed to contact the heated materials in the kettle. Water causes splattering similar to that with grease in a frying pan, only much more dangerous, and a large amount could cause a violent explosion. When working with hot binders, wear gloves, long pants, and long sleeved shirts. Keep your shirt collar and cuffs buttoned. Never run or hurry when carrying hot materials. If hot binder gets on you, do NOT attempt to rub it off. If it is a large amount, cool it down with water. These binders cool quickly and by the time you have spilled the binder, and hurried to get the water, there will be no danger of splattering. Report to sickbay immediately to have the wound cleaned to prevent infection.

In advanced base cantonment areas, small buildings like those shown in the background of figure 7-5 are roofed with corrugated, galvanized-iron sheets. Roof sheathing is not required as the buildings are only temporary. This type of construction is well-suited to tropical regions—particularly Southeast Asia. Incidentally, these buildings are officially known to SEABEES as "SEA huts."

Corrugated sheet metal should be handled with gloves to avoid cuts from the sharp edges. As this material is relatively light, be particularly careful when working in gusty, windy weather. A flying sheet of this material could take your head off.

HARDWARE

Builders' hardware includes various types of fasteners such as nails, screws, bolts, and hinges. If you will look around, you will probably see these and many other kinds of wood fasteners being used. A brief treatment of some of the more common types of hardware generally used in carpentry is given in the following sections.



45.499
Figure 7-4.—Building paper and felt in a 5-ply built-up roof covering.

29.409
Figure 7-5.—Builders working on the roof of a SEA hut. Completed corrugated roof coverings, weighted with sandbags, are shown in the background.

Nails

NAILS are the most commonly used wood fasteners in construction. They are easily manufactured and are quickly installed on the job, saving time and money. There are many kinds of nails, each designed for a particular purpose. The kind you will use most frequently is the wire nail.

WIRE NAILS are so called from the way they are made. Long steel wires are fed into a machine which cuts the nail to length and shapes its head. The more common types of wire nails are shown in figure 7-6.

The BRAD and FINISH NAIL are essentially the same shape. Both types are used mainly for interior finish work and both have small heads which can be driven (set) below the surface of the wood. In common trade terminology, the term "brad" is general used to describe the smaller nails of this type. There is no clear distinction between the two.

The CASING NAIL is similar to the finish nail, however, the head is larger and it is tapered for greater holding power. It is used on interior trim where more strength is required, and it is especially suited for nailing tongue-and-groove flooring where a large headed nail would be objectionable.

The COMMON NAIL has a relatively larger diameter and a FLAT HEAD. This is the type of nail used most frequently. Common nails over 6 inches long are called SPIKES.

BOX NAILS are smaller in diameter than common nails, and can be driven with less danger of splitting the lumber. Box nails, often used in constructing wooden boxes and crates, can be obtained either plain or cement-coated. This coating gives greater holding power.

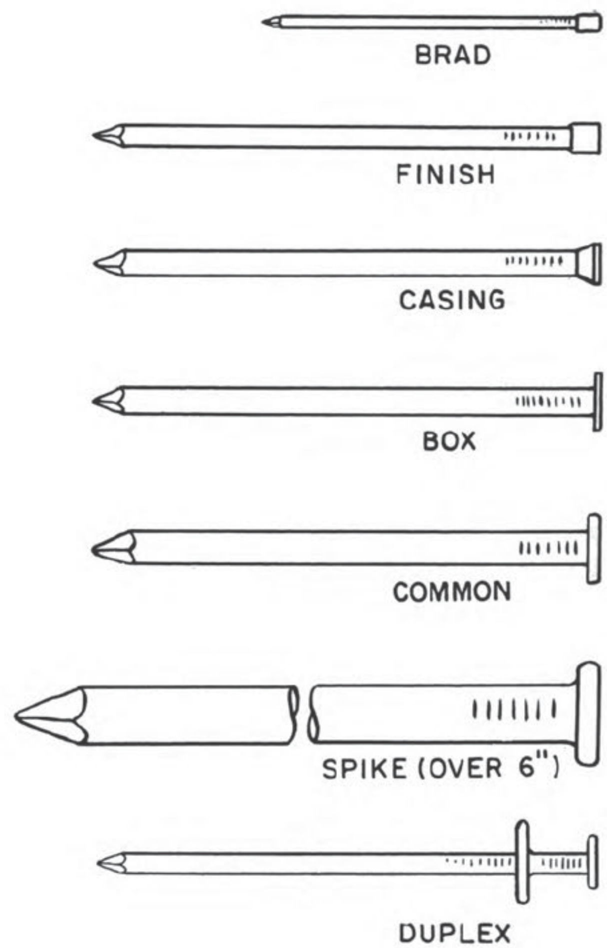
DUPLEX NAILS, also called double-headed or staging nails, are similar to common nails except for the double head. The nail is driven to the lower head; it can be easily withdrawn with a hammer or bar. Duplex nails are used extensively in temporary structures such as scaffolding and "falsework" for concrete forms.

CUT NAILS are "cut" from steel and are generally rectangular in shape. They have a greater holding power than round nails but are hard to drive and not so economical. Cut nails are used principally for installing hardwood flooring.

The lengths of the most commonly used nails are designated by the so-called PENNY SYSTEM. In this system, the abbreviation for the word "penny" is the letter "d." Thus, a 2d nail is called a "two-penny nail," and so on. Regardless of the type of nail, the same penny size will be the same length, however, the diameter will not always be the same. As a Constructionman, you are not required to memorize all the various types and sizes of nails.

A few important things to remember when nailing are: select a nail which is at least three times as long as the thickness of the wood it is intended to hold; drive nails at a slight angle towards one another; and take care when nailing over edges so as not to split the wood. A trick commonly used to help prevent splitting is to turn the nail over and to blunt the point before driving.

The most common accident, other than hitting your fingers, when nailing is caused by nails



29.121
Figure 7-6. — Common types of wire nails.

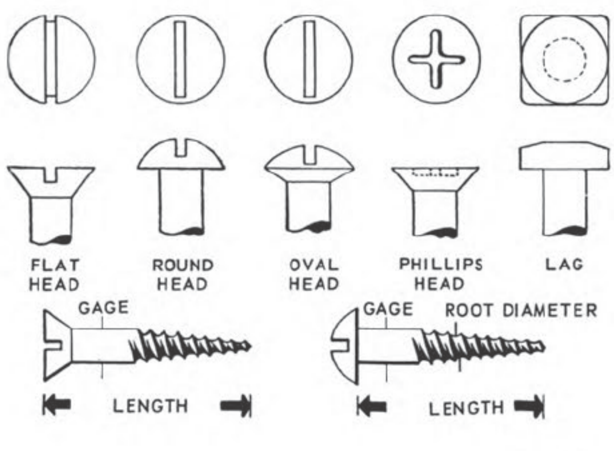
which have been hit a glancing blow and take off flying. These may travel several feet and they have been known to penetrate wood and clothing. The easiest way to prevent this is to take your time and watch what you are doing.

Wood Screws

WOOD SCREWS provide an effective means for fastening two pieces of wood securely together. They not only have exceptional holding power but also are easy to use. Four common examples of wood screws are illustrated in figure 7-7.

Wood screws are classified as to type by the shape of head and material, as "flathead brass," "roundhead steel," and so on. Most wood screws are made of either steel or brass, but there are others such as copper and bronze as well. To distinguish the orindary type of head from the "Phillips" head, the former is called a SLOTTED HEAD. A LAG SCREW is a heavy screw, generally of steel, with a square bolt-type head intended to be used with a wrench. Lag screws are used to fasten heavy timbers and to secure large and heavy objects such as machinery.

The size of an ordinary wood screw is designated by the SCREW LENGTH and the BODY DIAMETER (unthreaded part) of the screw. Body diameters are designated by GAGE NUMBERS running from 0 (about 1/16 inch dia.) to 24 (about 3/8 inch dia.). The length is equivalent to that portion of the screw actually inserted into the wood. For example, a flathead screw length includes the overall length, but a roundhead screw is measured up the base of the head.



29.123A
Figure 7-7.—Common types of wood screws.

The length and gage number are printed on the box, as "1 1/4 - 9". This means a No. 9 gage screw 1 1/4 inches long. Lag screws are an exception; and their diameter is expressed in inches, as is their length.

As a Constructionman and helper, you may be asked to assist in driving wood screws. To ensure satisfactory results, always select a screwdriver that fits the screw head. This will enable you to drive the screw quickly without marring either the screw or wood or causing an injury.

The proper way to prepare wood to receive a screw is shown in figure 7-8. A PILOT HOLE is bored first equal to the diameter of the screw. Next, a STARTER HOLE is bored to a depth of one-half to two-thirds the threaded portion, depending on the relative hardness of the wood. This starter hole should be about the average "root diameter" of the screw. The ROOT DIAMETER is the diameter of the threaded part measured between the base of the threads.

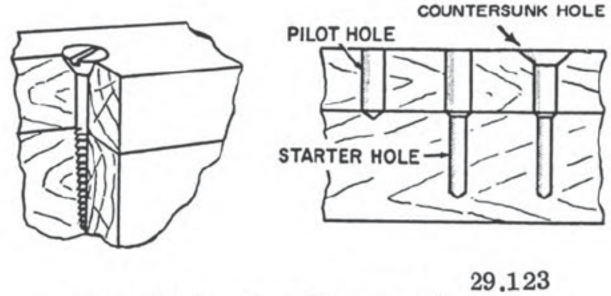
The purpose of this careful preparation is to assure accuracy in placement, to reduce the possibility of splitting, and to lessen the time and effort required to drive the screw.

Bolts

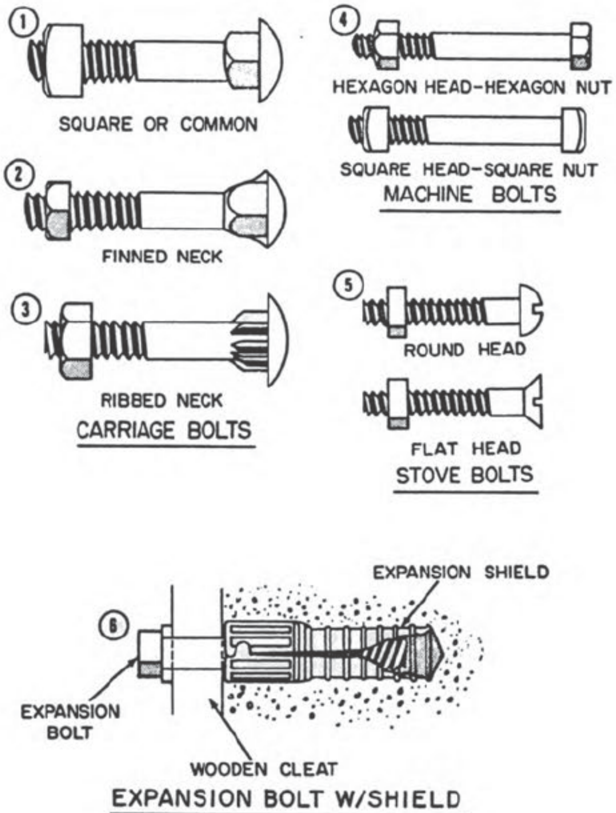
A BOLT is distinguished from a wood screw by the fact that it does not thread into the wood but goes through and is held by a NUT threaded on its end. Figure 7-9 shows common types of bolts used in woodworking.

The CARRIAGE BOLT has a square section below the head, which helps prevent the bolt from turning as it is drawn into the wood as the nut is tightened.

The MACHINE BOLT has either a square or hexagon-shaped head, which is held with a wrench as the nut is tightened. A flat washer must be



29.123
Figure 7-8.—Installing wood screws.



29.124
Figure 7-9.—Common bolts.

placed under its head to prevent it from drawing into the wood.

STOVE BOLTS are generally small and the heads are shaped similar to many wood screws. They are tightened with a screwdriver.

An EXPANSION BOLT and EXPANSION SHIELD are used where regular threaded fasteners are useless, such as in concrete or in masonry walls. The expansion shield (or anchor) is inserted into a pre-drilled hole and then as the bolt is turned it expands and becomes firmly wedged in the hole.

Bolts are used in construction where great strength is required or when the item constructed must be frequently disassembled. The use of washers between the nut and the wood or under the head of certain types will prevent marring the surface and permit additional torque in tightening. Use only the size wrench which fits the nut properly.

Holes must be bored to receive any type of bolt. In soft wood the hole can be the same diameter as the bolt; however, in hard wood, the hole should bored slightly larger than the bolt diameter. It is advisable to put a drop or two of oil on the bolt/nut before threading.

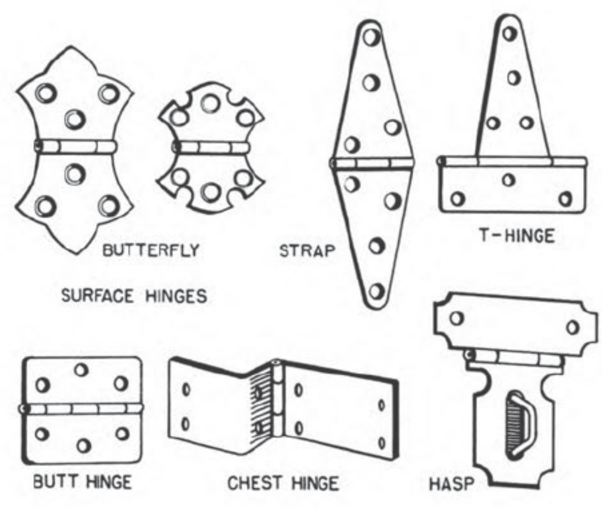
Hinges

Cabinets, lockers, doors, chests, and so on, often require HINGES as fastening devices. Some commonly used hinges are pictured in figure 7-10.

SURFACE hinges are screwed onto the outside of the door with the pin directly over the crack. The offset CHEST hinge is best and strongest for sea chests and boxes. The HASP provides a way to secure doors and lids with a padlock. BUTT hinges have two leaves and can have a removable pin; these hinges are frequently used in hanging doors. Butt hinges are "gained" into the wood so that only the pin part shows when the door is closed.

Locks

Builders use a variety of locks to secure doors, closets, or cupboards. In general, these are roughly divided into two types, the mortise lock and the rim lock. MORTISE LOCKS are "mortised" or "let-in" the door in a mortise, slot, or hole. Years ago most mortise locks were generally rectangular in shape and they were installed in a similarly shaped mortise in



29.125
Figure 7-10.—Common hinges.

the edge of the door. Today however, most mortise locks are the cylindrical type (fig. 7-11). The CYLINDER LOCK is installed in one or more large holes bored completely through the door, and they are usually adjustable to several door thicknesses.

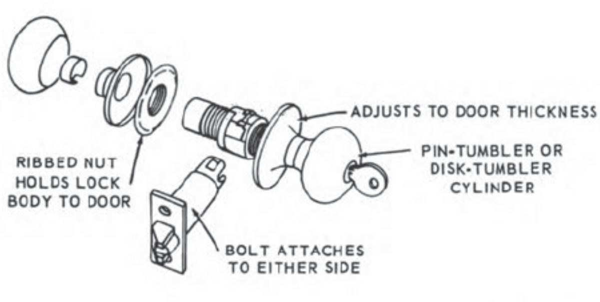
The RIM LOCK is mounted to the inside surface of the door and is much easier to install. Some types of rim locks can only be opened with a key from the outside, lacking a knob or handle.

CARPENTRY TOOLS AND EQUIPMENT

As a Constructionman, you are required to use and care for common measuring tools, clamps and vises, and common hammers. In addition, you should be able to identify and care for many other basic handtools and portable power tools.

A Builder in the SEABEES uses a variety of handtools and power tools. The type of tool he uses varies with the kind of work he does. Tools are designed to suit particular needs; and a good Builder acquires the ability to select and use the correct tools and equipment of his trade effectively and skillfully.

A few of the tools used in carpentry operations are described below to familiarize you with their appearance, common usage, care, and applicable safety precautions. A detailed description of how to use them, however, is beyond the scope of this training manual. If you are assigned as a Builder's helper, take care to observe him closely when he uses his tools. If you show interest in learning to become a Builder, he will take time to show you how to use them properly, while he is accomplishing his normal work. Be attentive and don't fail to ask questions about any of this actions that you don't fully understand.



133.161
Figure 7-11.—Cylinder type mortise lock.

CARPENTRY HANDTOOLS

The majority of handtools described in this section are found in the Carpenter's Tool Kit available in all SEABEE construction battalions.

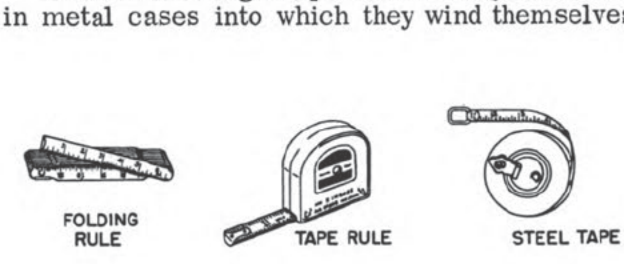
Measuring and Layout Tools

The ability to do accurate work depends on the correct use of measuring and layout tools and the ease with which the graduations are read. In general carpentry the measuring tools you will use most frequently are the folding rule, flexible-rigid tape rule, and steel tape. You will learn that the majority of layout work is based on problems involving the right triangle—that is, a triangle with at least one 90° angle. Several types of squares have been developed to help in this work. The ones you will use are the carpenter's square, framing square, try square, and combinatkon square.

FOLDING RULE.—The folding rule (fig. 7-12) is generally a 6-ft rule, which folds up accordion style. Some types, called extension rules, are equipped with a sliding extension at the zero end. The extension is used to take inside measurements, such as the distance between the sides of a door or window opening. Folding rules cannot be relied on for extremely accurate measurements because a certain amount of play develops at the joints after they have been used for a while.

STEEL TAPES.—Steel tapes (fig. 7-12) are made from 6 to about 100 feet in length. In the shorter lengths, these are frequently made with a curved cross section so that they are flexible enough to roll up, but remain rigid when extended. These are the so called FLEXIBLE-RIGID TAPE rules. Long, flat tapes require support over their full length when measuring, or the natural sag will cause an error in measuring.

The flexible-rigid tapes are usually contained in metal cases into which they wind themselves



44.24
Figure 7-12.—Common measuring tapes.

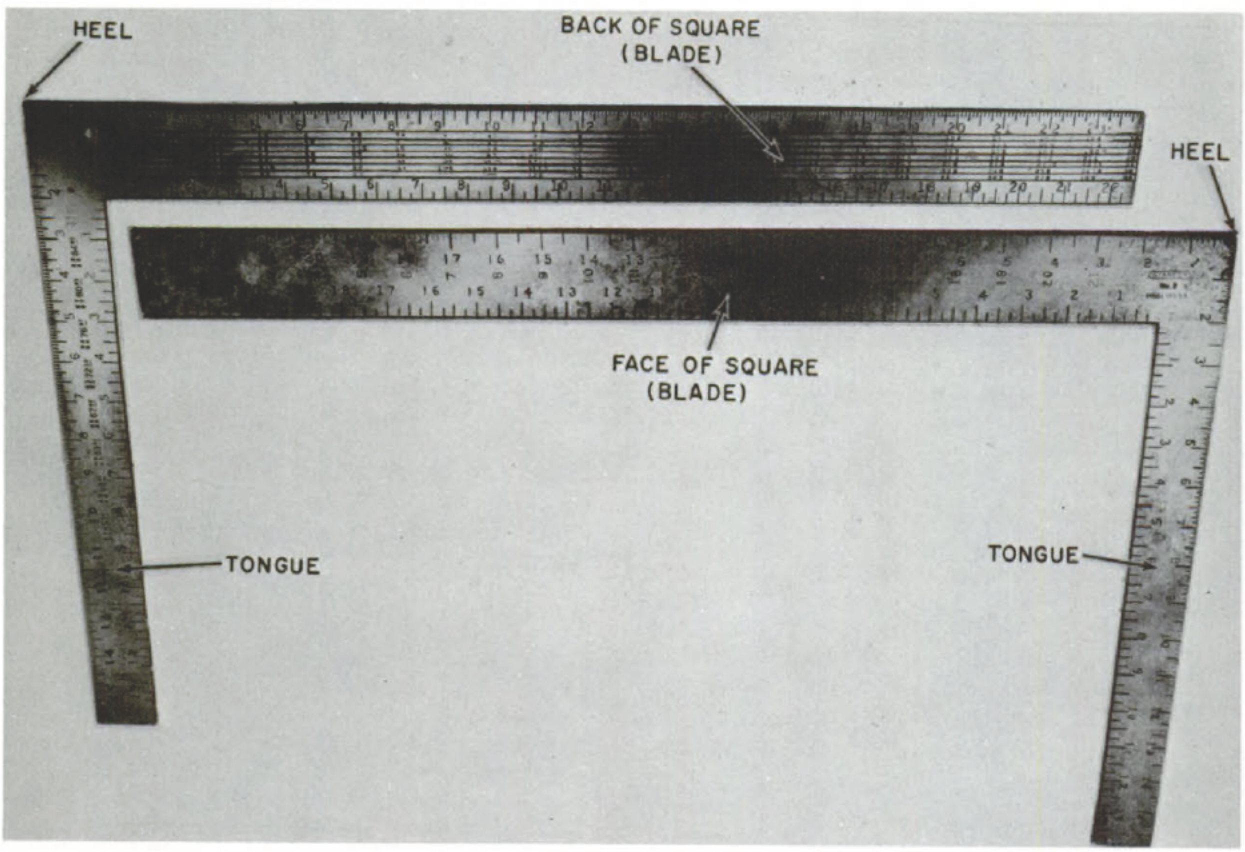
when a button is pressed, or into which they can be pushed. A hook is provided at the end to hook over the object to be measured so one man can handle it without assistance. On some models, the outside of the case can be used as one end of the tape when measuring inside dimensions.

CARE OF RULES AND TAPES.—Rules and tapes should be handled carefully and kept lightly oiled to prevent rust. Never allow the edges of measuring devices to become nicked by striking them with hard objects. They should be kept in a wooden box when not in use.

To avoid kinking tapes, pull them straight out from their cases—do not bend them backward. With the wind-up type, always turn the crank clockwise—turning it backward will kink or break the tape. With the spring-wind type, guide the tape by hand; if it is allowed to snap back, it may be kinked, twisted, or otherwise damaged.

CARPENTER'S SQUARE.—The carpenter's square is a steel square usually 12 x 8 inches, 24 x 16 inches, or 24 x 18 inches. The longer and wider side is called the BLADE and the shorter and narrower side, which is at right angles to the blade, is called the TONGUE. (See fig. 7-13.) The corner where the two sides meet is called the HEEL. The FACE of the square is the side you see when holding the blade in your left hand, tongue in your right, and the heel pointed away from your body. In this same position, the otherside is known as the BACK.

A Builder uses the carpenter's square to solve many problems in construction involving the right triangle such as, laying out roof rafters, braces, and stairs. You will use it primarily to measure short distances, to mark 90° lines



29.23A
Figure 7-13.—Carpenter's square.

for cutting, and for testing the flatness and squareness of surfaces.

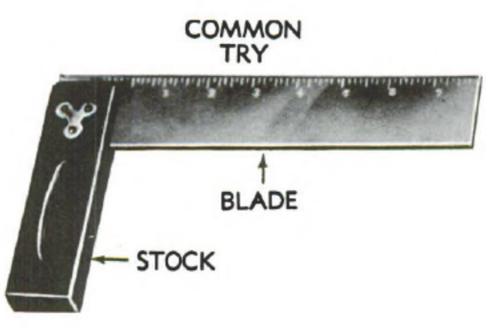
FRAMING SQUARE.—The framing square is similar to the carpenter's square. However, the blade is invariably 24 inches long and the tongue 16 inches. On the face is a table (UNIT LENGTH RAFTER TABLE), which is used to determine the lengths and cuts of various rafters. On the inside edge of the tongue on the back of the square, the inch marks are graduated in TENTHS of an inch.

On the back of both the carpenter's and framing square, the outer edges of the tongue and blade are graduated in TWELFTHS of an inch. This is important to remember in order to prevent mistakes when measuring.

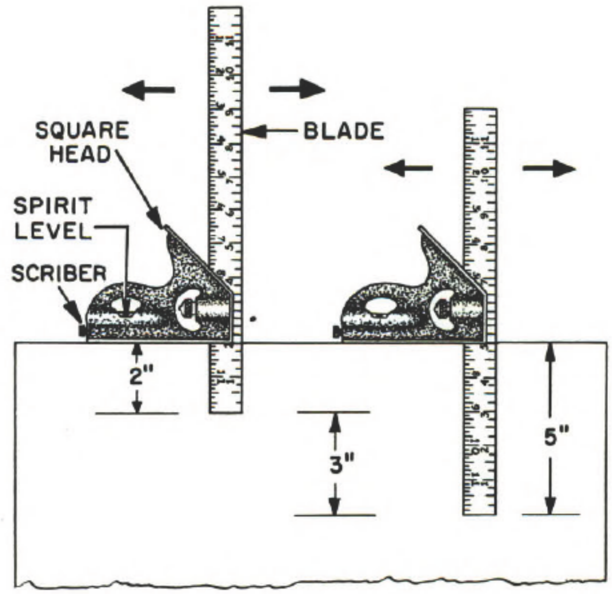
TRY SQUARE.—The try square (fig. 7-14) consists of two parts at right angles to each other; a thick wood or iron STOCK and a thin, steel BLADE. The try square is used for marking or checking lines or surfaces which have to be at right angles to each other. It is handier, for most uses, than the carpenter's square. Some types of try squares have a stock adapted for marking 45° angles. This type is called a COMBINATION TRY SQUARE.

COMBINATION SQUARE.—The combination square used by Builders consists of a SQUARE HEAD and a BLADE which can be moved back and forth by means of a BLADE FRICTION SCREW. In addition to the usual capability of testing and marking 90° and 45° angles, the combination square can be used as a depth gage or marking gage. It is particularly useful for drawing parallel lines, as in figure 7-15.

In most models of combination squares, there is a small SPIRIT LEVEL built into the head and



44.25
Figure 7-14.—Common try square.



28.17
Figure 7-15.—Drawing parallel lines with a combination square.

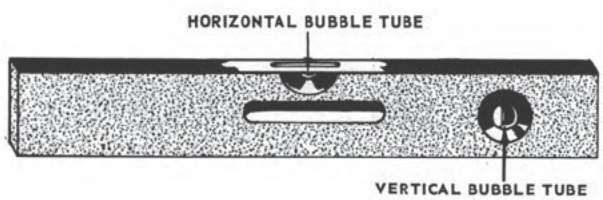
a small SCRIBER is housed in a hole in the end of the head. The scriber is used to mark layout lines.

SLIDING T-BEVEL.—The sliding T-bevel (fig. 7-16) is an adjustable try square with a slotted beveled blade. Blades are normally 6 or 8 inches long. The sliding T-bevel is used for laying out angles other than right angles, and for testing constructed angles such as a bevel. These tools are made with either wood or metal handles.

CARE OF SQUARES.—Squares require minimal maintenance. Make certain the blades, head, and other parts are kept clean and lightly coated with oil to prevent rust when not in use. Do not use squares for purposes other than those intended. Be careful that they are not dropped and/or placed where they can be stepped on. A bent square is useless.

CARPENTER'S LEVEL.—The carpenter's level (fig. 7-17) is not exactly a "measuring" tool, however, it is an important layout and testing tool. It consists of a long, narrow, rectangular hardwood or metal FRAME, with true and parallel edges and ends and two or more BUBBLE-TUBES.

44.26
Figure 7-16.—Sliding T-bevel.



29.13
Figure 7-17.—Carpenter's level.

Its principal use is to determine whether or not an object or line is LEVEL (truly horizontal) or PLUMB (truly perpendicular to level). The bubble-tube set lengthwise in the center of the level is used for LEVELING. True level is indicated when the bubble in the tube rests centered between the two hairlines on the glass. A similar bubble-tube, set crosswise at the end (or at both ends), is used for PLUMBING.

CARE OF LEVELS.—Keep levels clean and avoid excessive wetting of wooden levels to prevent the wood from swelling and warping. Levels must not be dropped or placed where they can easily be knocked down. When not in use, levels are best stored by hanging them vertically. NEVER use the bubble-tube opening for hanging the level.

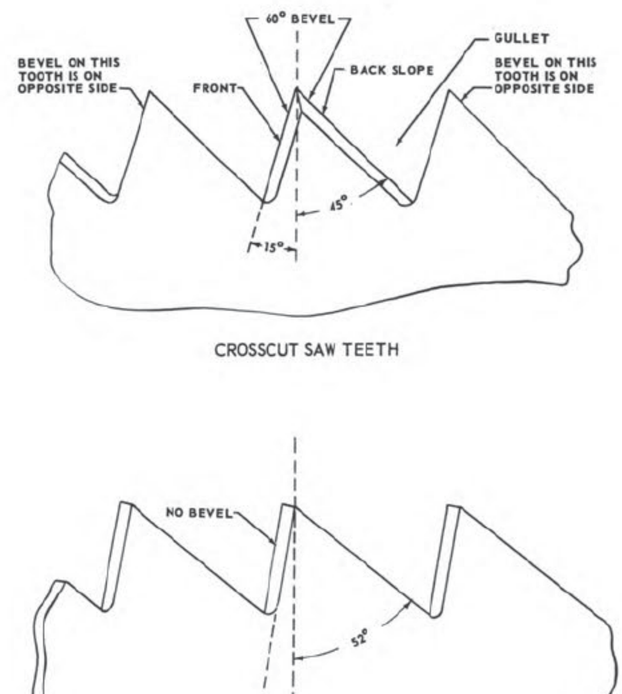
Woodcutting Tools

Common woodcutting handtools are saws, planes, chisels, and augers. Others used less frequently are the spokeshave, drawknife, and rasps and files.

HANDSAWS.—A handsaw is, in a sense, a type of "shaving" tool like the plane (discussed later), in which a series of tiny blades, instead of a single large blade, do the cutting. Each of the little blades on a saw is called a TOOTH. Each tooth terminates in a POINT; and a saw with 8 points to the inch, for instance, is called an 8-POINT saw. To prevent the saw from binding in the KERF (saw cut), the teeth are bent alternately, one to one side and the next to the other, so that the kerf will be wider than the metal of the saw blade. Bending the teeth in this manner is called SETTING the saw.

Woodworking handsaws include RIPSAWS and CROSSCUT saws; the ripsaws are designed for cutting with the grain of the wood and the crosscut saws are for cutting across the grain.

The major difference between the ripsaw and a crosscut saw is the shape of the teeth (fig. 7-18). The ripsaw has square-faced chisel-type teeth and they do a good job of lengthwise cutting (RIPPING), but a poor job of crosswise cutting (CROSSCUTTING). The crosscut saw has teeth with a beveled, knife-type cutting edge which



29.158
Figure 7-18.—Crosscut saw and ripsaw teeth.

do a good job of cutting across the grain, but a poor one along the grain.

A variety of other handsaws, designed to serve special purposes, are designated by particular names, as BACKSAW, COMPASS SAW, COPING SAW, and so on. (See fig. 7-19.)

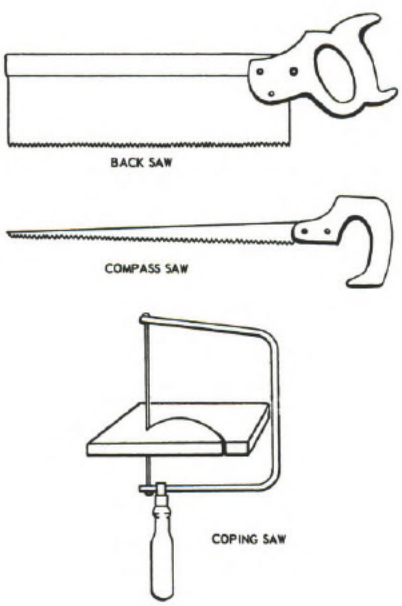
The BACKSAW is a crosscut saw designed for sawing perfectly straight cuts. A heavy steel BACKING along the top of the blade keeps the blade straight. The backsaw is often used in a miter box.

A MITER BOX permits sawing a piece of stock to a given angle without a line. Figure 7-20 shows a common type of wooden miter box. Stock can be cut at 45° by placing the saw in cuts M-S and L-F, or at 90° in cut A-B. Steel miter boxes are also available.

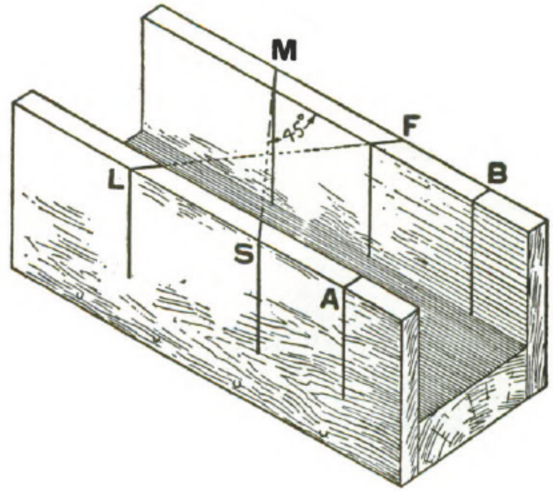
The COMPASS SAW is a long, narrow, tapering saw designed for cutting out circular or other shaped sections from within the margins of a board or panel. A hole is bored near the cutting line to start the saw. A KEYHOLE saw is simply a finer, narrower compass saw used to cut holes with a smaller radius.

The COPING saw is used to cut along curved lines as shown in figure 7-19.

CARE OF SAWS.—On the job, a saw which is not in actual use should be hung up. As a note of safety, be careful where you drive nails to hang the saw. Without the saw actually hanging there, the nails are hard to see and persons have been known to lean against them, causing injuries and snagging clothing. Do not stow saws loosely in the tool kit or against other metal tools which may damage the teeth. Use wooden spacers with notches designed to hold the saw on edge and protect the teeth. Keep the blades clean (turpentine can be used to remove pitch and resin) and lightly coated with a rust preventing oil. Remove the handle periodically to check if the blade underneath is OK and put a drop or two of oil on the bolts.



29.20:.22
Figure 7-19.—Special saws.

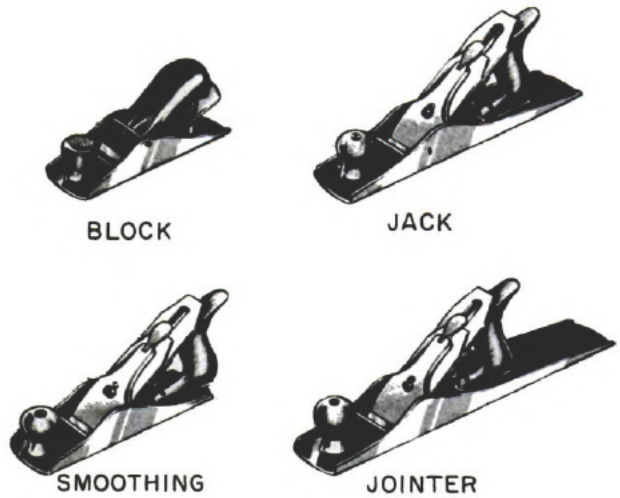


68.10X
Figure 7-20.—Wooden 45° miter box.

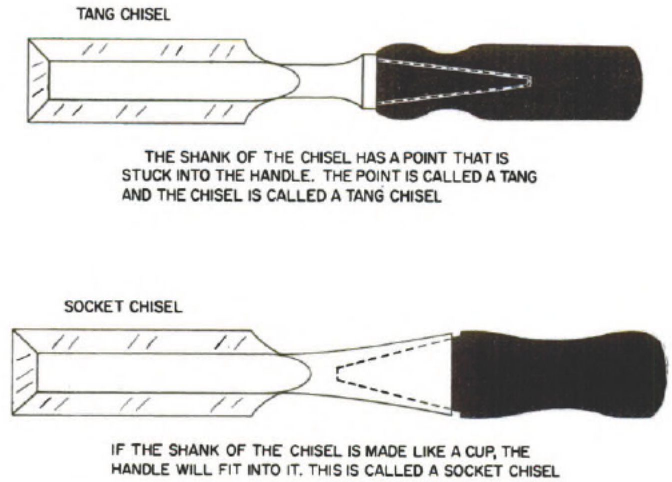
PLANES.—The plane is the most extensively used of the so-called "shaving" tools. Most wood now-a-days comes dressed on all four sides, but when Builders are fitting doors and windows, and installing cabinets and trim, planes must be used.

There are four commonly used types of planes (fig. 7-21); the BLOCK plane, the SMOOTHING plane, the JACK plane, and the JOINTER plane. The principal difference between each is their length. The block plane is usually about 6 inches long, the smoothing plane about 9 inches long, the jack plane about 14 inchs long, and the jointer plane from 20 to 24 inches long. The longer the plane is, the more uniformly flat and true the planed surfaces will be.

The smaller block plane is used chiefly for cross-grain squaring of end stock. It is also used for smoothing all plane surfaces on very



29.12
Figure 7-21.—Common types of planes.



29.9B
Figure 7-22.—Tang and socket wood chisels.

small work. The other three types are used primarily for smoothing with the grain.

The smoothing plane is, in general, a smoother only. It will plane a smooth, but not an especially true, surface in a short time. It can also be used for cross-grain squaring and smoothing of large end-stock.

The jack plane is the general "jack-of-all-work" of the plane group. It can take a deeper cut, and plane a truer surface, than the smooth plane.

The jointer plane is used when the planed surface must meet the highest requirements with regard to trueness.

CARE OF PLANES.—As with saws, and the majority of other cutting tools, planes must be kept clean and metal and moving parts lightly oiled. When not in actual use, they should be laid on their side to protect the cutting edge; and when stored in the tool kit, be sure that the cutting edge has been withdrawn above the bottom of the plane.

WOOD CHISELS.—All wood chisels may be divided into two general classes, according to how their handles are attached; TANG chisels, in which part of the chisel (called the TANG) enters the handle, and SOCKET chisels, in which the handle enters into part of the chisel (called the SOCKET). (See fig. 7-22.)

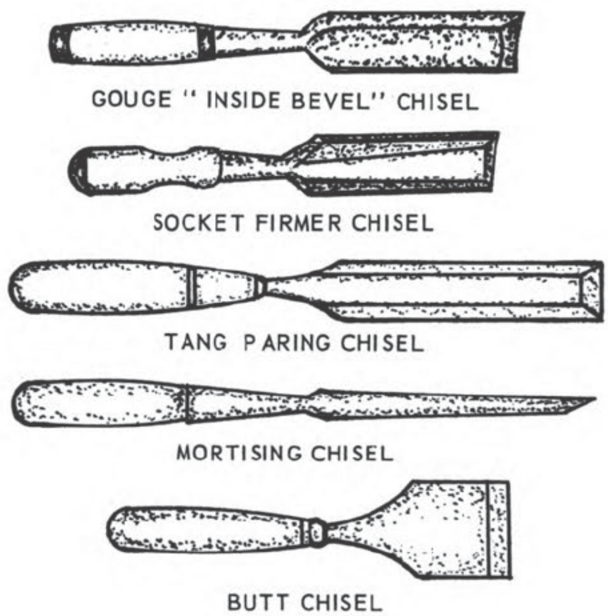
A socket chisel is designed for striking with a mallet (never a steel hammer), while the tang chisel is designed for hand manipulation only.

The shapes of some of the common types of wood chisels are shown in figure 7-23. The FIRMER chisel has a strong, rectangular cross-section blade, designed for both heavy and light work. The blade of the PARING chisel is relatively thin, and is beveled along the sides for fine paring work. The BUTT chisel has a short blade, designed for work in hard-to-get-at places. The butt chisel is commonly used for chiseling the gains (rectangular depressions) for the butt hinges on doors; hence the name. The MORTISING chisel has a narrow blade, designed for chiseling out the deep, narrow mortises for mortise-and-tenon joints. This work requires a good deal of levering out of chips; consequently, the mortising chisel is made extra-thick in the shaft to prevent breaking.

A FRAMING chisel (not illustrated) is shaped like a firmer chisel, but has a very heavy, strong blade, designed for work in rough carpentry.

A GOUGE (fig. 7-23) is simply a chisel with a curved, instead of a straight, blade. If the bevel is on the convex side of the blade, the gouge is an OUTSIDE BEVEL gouge; if it is on the concave side, the gouge is an INSIDE BEVEL gouge

CARE OF CHISELS.—Except for sharpening and an occasional replacement of a handle, both of which should be done by an experienced Builder,



29.9C

Figure 7-23.—Shapes of common types of wood chisels.

chisels need little special care. The most important thing to remember is to keep the cutting edges protected. Wrapping them in plastic, canvas, or heavy paper helps to do this and you should keep a few rubber bands handy to hold the wrapping in place. Keep the metal coated lightly with a rust preventative but be careful to keep it off the handles. A quick way of judging a good Builder is by looking at the condition of his chisels. Remember this if you intend to strike for Builder!

SPOKESHAVE.—The spokeshave (fig. 7-24) is a small, two-hand plane that is pulled instead of pushed in cutting. It is used primarily to plane curved edges or to shape and smooth cylindrical stock.

DRAWKNIFE.—The drawknife (fig. 7-25) is a two-hand cutter like the spokeshave; and it is also pulled toward the operator in cutting. The blade has a single-bevel edge, like that of a chisel. The drawknife is principally used for rough-shaping round timbers and for removing a heavy edge-cut prior to finish planing.

FILES AND RASPS.—Files and rasps, although cutting tools, are commonly referred to as "abrasive" tools because of their unique cutting action. They are used for wood shaping only when the of other cutting tools is impossible.

Files are classified according to the shape of their cross section and the manner in which the teeth are cut, as shown in figure 7-26. The teeth on a rasp consist of triangular projections. Most rasps are half-round in cross section. Since a rasp cuts wood much faster than a file, and leaves a much coarser surface, rough shaping is usually done with the rasp and final smoothing with the file.

Most files and rasps have the tang type of handle attachment. ALWAYS PUT ON A HANDLE BEFORE USING THE TOOL to avoid the possibility of puncturing the hand with the tang. To seat the tang firmly in the handle, tap the butt of the handle on a hard surface. DO NOT HAMMER THE FILE INTO THE HANDLE.

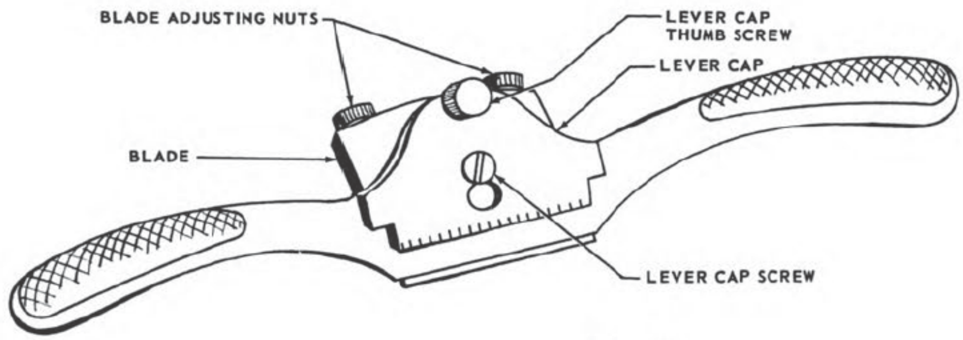
To get good results when filing, remember that the file only cuts as you push it. Keep your feet spread apart to steady yourself and file with slow, full-length, steady strokes. Lift the file away from the surface of the work on the return stroke.

CARE OF FILES AND RASPS.—Keep the file clean. The best method is to clean it frequently with a FILE CARD or wire brush. A file card (fig. 7-27) has fine wire bristles. Brush with a pulling motion, holding the card parallel to the rows of teeth.

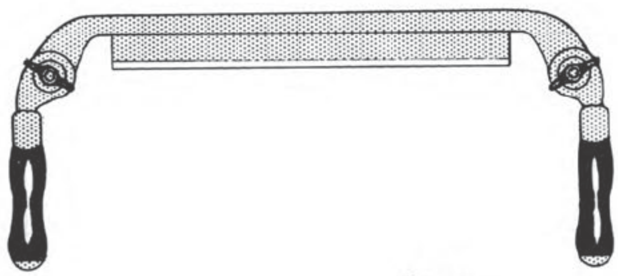
Protect the teeth of files and rasps by hanging the tools on a rack when they are not in use, or by placing them in drawers with wooden partitions. Files that are kept in your tool kit should be wrapped in paper or cloth to protect their teeth and prevent damage to other tools. Keep your files away from water and moisture to prevent rusting. Avoid getting the files oily, as it causes them to slide over the work and prevents fast, clean cutting.

Never use files and rasps for prying or pounding. The tang is soft and bends easily. The BODY is hard and extremely brittle. Even a slight bend or fall to the deck may cause a file to snap in two.

BITS AND DRILLS.—The terms BITS and DRILLS are sometimes confusing to the new SEABEE. Woodworkers and metalworkers distinguish between the two according to the use for which they are made. BITS are made specifically for BORING (not drilling) holes in wood, whereas DRILLS are made for DRILLING holes in metal.



133.58
Figure 7-24.—Spokeshave.



133.59
Figure 7-25.—Drawknife.

Like saws and planes, bits vary in their shape and structure, depending upon the type of job to be done. The most common bits are described here. Various types of hand drills and their uses are covered in Basic Handtools.

Small bits, similar to twist drills, are used for boring holes for screws, dowels, and hardware, as an aid in mortising, and for many other purposes.

Each Carpenter's Tool Kit contains a set of AUGER BITS and one EXPANSIVE BIT (also called an AUGER). Auger bits are screw-shaped tools consisting of six parts: cutter, screw, spur, twist, shank, and tang. (See fig. 7-28.) The twist ends with two sharp spurs, which score the circle, and two cutting edges which cut shavings within the scored circle. The screw centers the bit and draws it into the wood. The twist carries the cuttings away from the cutters and deposits them around the hole.

The sizes of augers are indicated in sixteenths of an inch and are stamped on the tang. A number 10 on the tang means 10/16 or 5/8 inch; number 5 means 5/16 inch, and so on. Expansive auger bits (fig. 7-29) have adjustable cutters for boring holes of varying diameters. A scale on the cutter blade indicates the diameter of the hole to be bored.

CARE OF BITS.—Keep bits carefully stored in there original containers or wrapped similar to chisels to protect the screw, spurs, and cutting edges. A light coat of oil will help prevent rust.

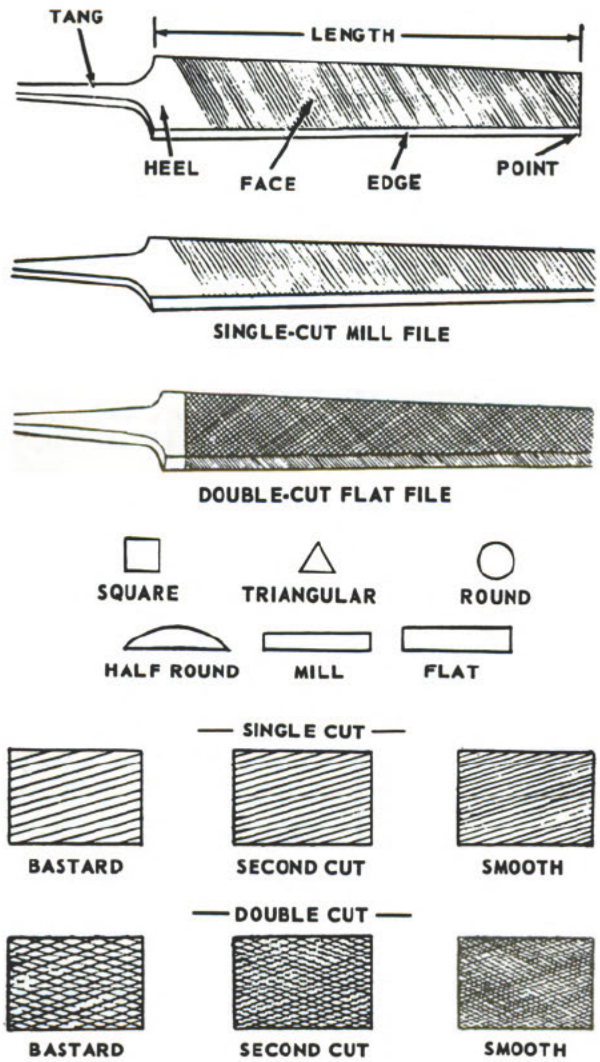
Striking Tools

The "striking" tools most commonly used by Builders are claw hammers, mallets, and sledges.

CLAW HAMMERS.—Claw hammers are designed for driving and drawing (pulling out) nails. They may have either a curved or straight claw. Straight clawed hammers, commonly called ripping hammers, are useful for prying apart boards when disassembling temporary structures. The hammer's FACE may be either BELL-FACED or PLAIN-FACED. (See fig. 7-30.)

Claw hammer size is designated by the weight of the head; and the most common sizes are 13 oz., 16 oz., and 20 oz. Lighter hammers are used for finish work and the heavier ones for rough work.

Simple as hammers are, there is a right and wrong way of using them (fig. 7-31). The most common mistake is holding the handle too close to the head. This is known as CHOKING the hammer and not only does it reduce the force of the blow, but it generally results in a glancing blow which bends the nail. Try to hit the

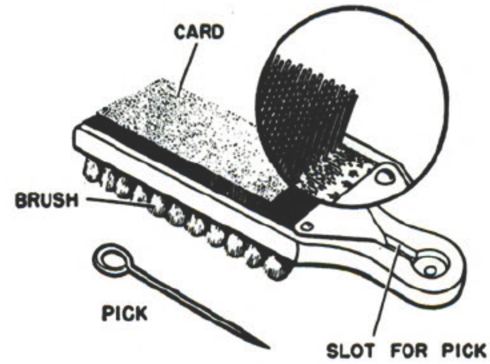


1.20
Figure 7-26.—Types of files.

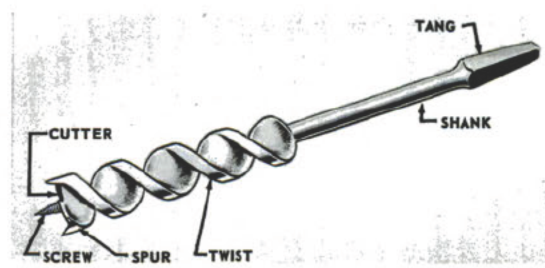
nail with the full face of the hammer. To do this you must practice swinging your arm and hammer from the elbow and not from your wrist.

Wooden handles often get slippery with use, particularly in hot weather when you are perspiring. Some Builders wrap friction tape around the lower part of the handle to help prevent this. You can also roughen up the handle with a file or sandpaper.

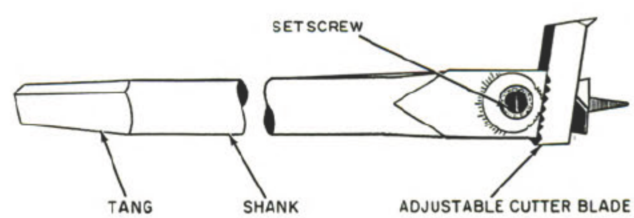
The hammer handle is held securely in the head by small wood or steel wedges. They may work loose and the hammer should never be



44.11
Figure 7-27.—File card.



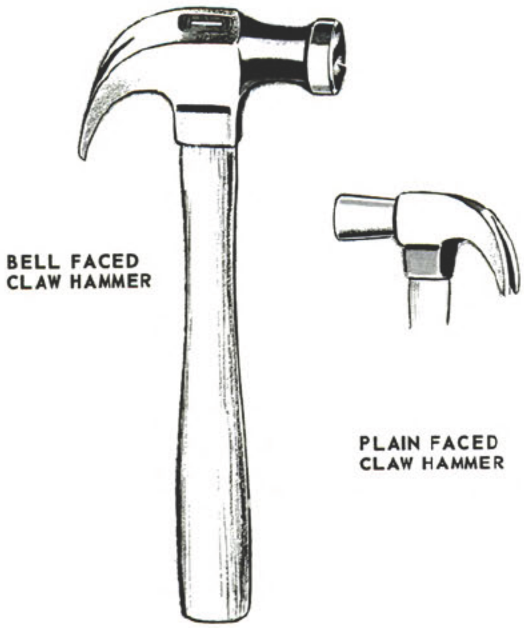
44.20
Figure 7-28.—Nomenclature of an auger bit.



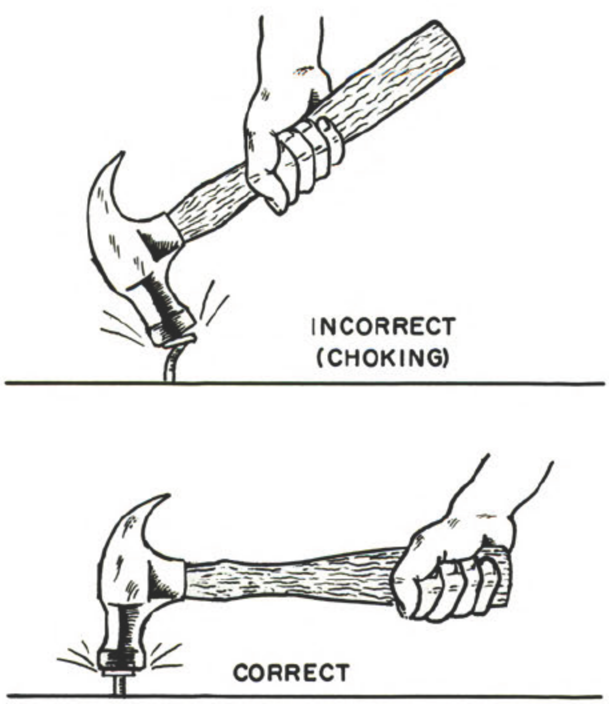
44.21
Figure 7-29.—Expansive bit.

used in this condition. A loose head can be tightened by removing the loose wedges and driving larger ones, or by driving extra wedges alongside those already in the handle. If neither of these measures work, you will have to replace the handle.

The procedure for replacing a handle is as follows. If the handle cannot be driven out of the socket, saw it off just below the head. To



5.5(133D)
Figure 7-30.—Two types of claw hammers.



5.5.1(44A)B
Figure 7-31.—Swinging the claw hammer.

loosen the part left in the head enough for driving out, bore one or more holes through it. Drive out the part and select a new handle with a socket end slightly larger than the socket. Shape the socket end to a tight fit in the socket with a spokeshave and/or a rasp. Seat the handle firmly in the socket by driving it in with the mallet. Saw off any segment which extends beyond the hammer head, drive in the wedges, and file or grind down the end of the handle flush with the top of the head.

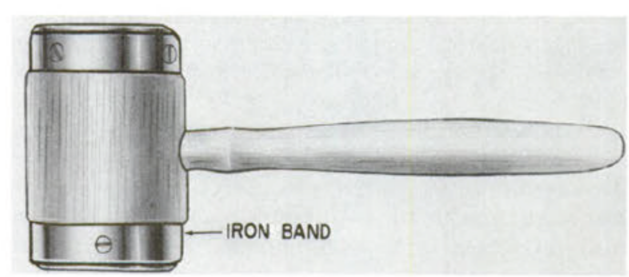
MALLETS.—The mallet (fig. 7-32) is a short-handled tool used to drive wooden-handled chisels, gouges, wooden pins, and small stakes. The cylindrically shaped head is made from a soft material, usually wood, rawhide, or plastic. The two flat driving faces are generally reinforced with iron bands (fig. 7-32).

The hammer and mallet are swung in the same manner. Never use a mallet to drive nails, screws, or any object that may cause damage to the face.

SLEDGES.—The SLEDGE is a steelheaded driving tool that can be used for a number of purposes. Short-handled sledges are used to drive bolts, driftpins, and large nails, and to strike cold chisels and small hand rock drills. Long-handled sledges are used to break rock and concrete, to drive spikes, bolts, or stakes, and to strike rock drills and chisels.

The head of a sledge is generally made of a high carbon steel and may weigh from 6 to 16 pounds. The shape of the head will vary according to the job for which the sledge is designed.

CARE OF STRIKING TOOLS.—Hammers, sledges, or mallets should be cleaned and repaired if necessary before they are stored. Hammer and sledge faces should be free from

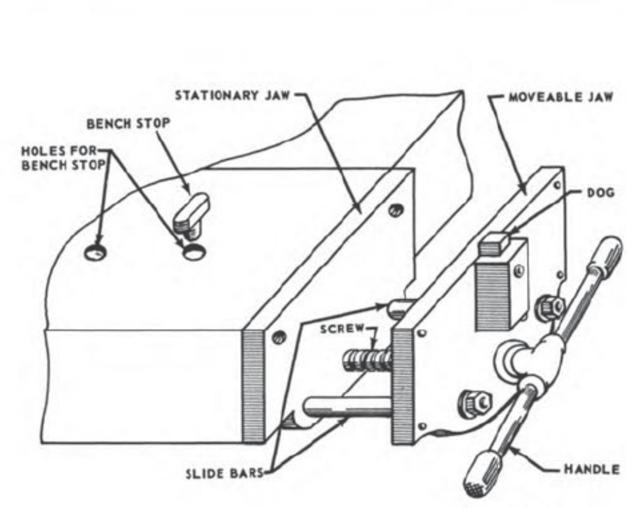


44.2
Figure 7-32.—Steel reinforced wooden mallet.

oil or other material that would cause them to glance off nails, spikes, or stakes. The hammer heads should be dressed to remove any battered edges. Inspect the handles of striking tools and make sure they are secure to the head and do not have any cracks or splinters. Never use a claw hammer to drive metal chisels or any other hard metal tools or objects. The face is hardened for driving nails only; and it will chip and dent easily if used to hammer hardened steel.

Never hammer anything with the flat of the claw hammer. The metal on the flat is thin and easily broken.

Never leave a wooden or rawhide mallet in the sun, as it will dry out and may cause the head to crack. A light film of oil on the sides will help to retain a little moisture in the head.



133.64
Figure 7-33.—Woodworking bench vise.

Equipment for Holding Work

A woodworking BENCH VISE, designed for holding work for planing, sawing, or chiseling on the bench, is shown in figure 7-33. Turning the SCREW by means of the HANDLE causes the MOVABLE JAW on the vise to move in or out on the SLIDE BARS (sometimes called the GUIDE BARS). On a vise with a CONTINUOUS SCREW the movable jaw must be threaded all the way. On a vise with an INTERRUPTED SCREW (which is called a QUICK-ACTING vise) the movable jaw can be slid rapidly in or out when the screw is in a certain position. When the jaw is in the desired position against the work, the quick-acting vise can be tightened by a partial turn of the handle.

Most woodworking vises are equipped with the DOG shown in the figure. The dog, which can be raised as shown or lowered flush with the top of the vise, is used in conjunction with a BENCH STOP to hold work which is too wide for the maximum span of the vise.

The screws and slide bars on vises should be lubricated regularly with preservative lubricating oil. Never hammer the jaws of a vise, and never use a woodworking vise to hold a metal article. Never use a piece of pipe or similar device to increase the leverage of the handle. The reason is that the increase in leverage may result not only in breakage of the handle, but also in damage to the screw and the jaws.

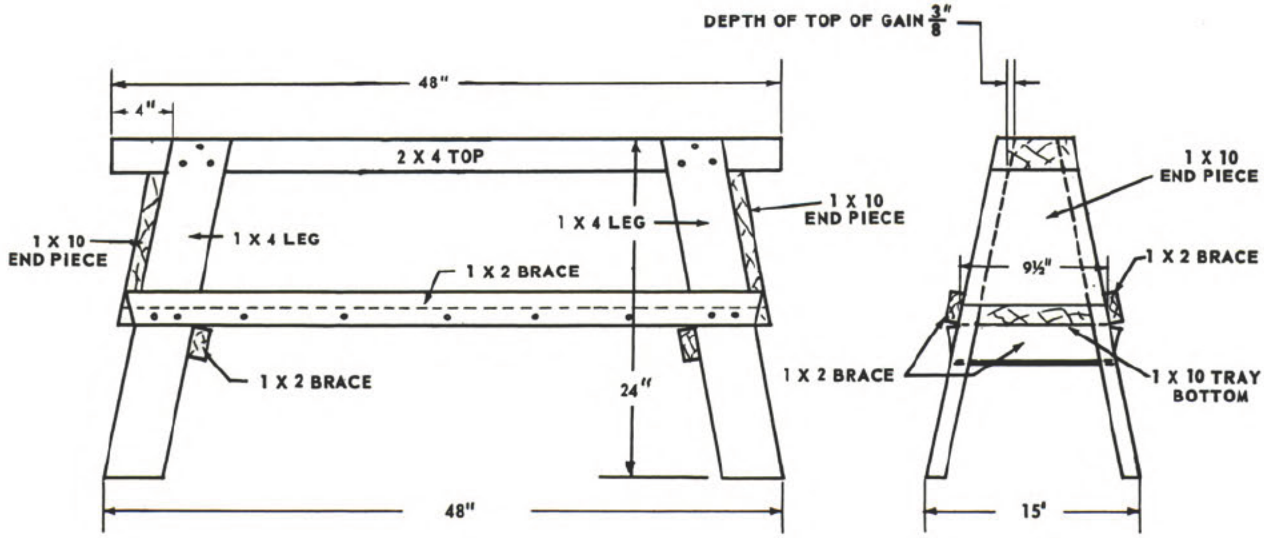
The SAWHORSE might be called the Builder's portable workbench and scaffold. Generally, the Builder makes his own sawhorse, if one is not already available. He would use the carpenter's square to compute the lengths and to mark the cuts for the legs, top and side pieces for the sawhorse. A working drawing of a good, sturdy sawhorse is shown in figure 7-34.

There are many types of CLAMPS used for holding work. The three types commonly used by woodworkers are shown in figure 7-35. Clamps are used in a variety of ways; and perhaps the most common use for all of them is clamping pieces together for gluing.

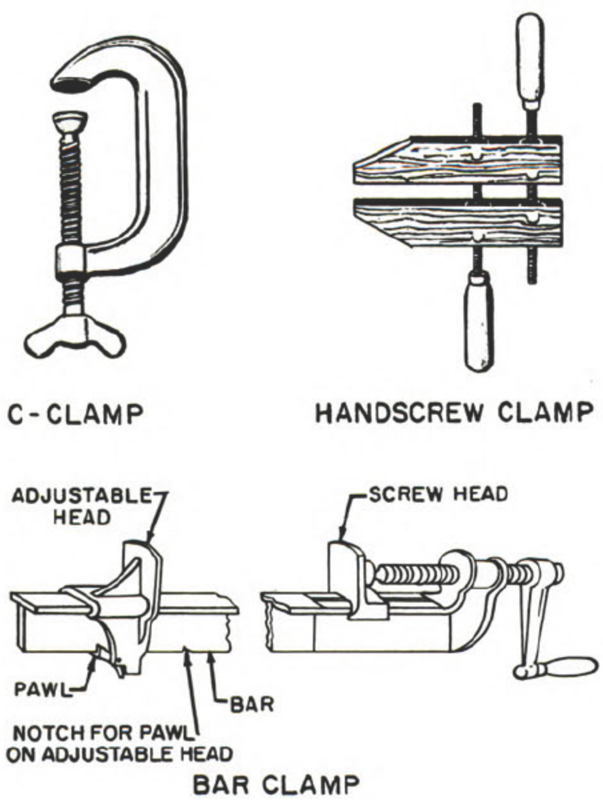
When the metal C-CLAMP is used for wood, the wood must be protected against damage from the metal jaw and the screw swivel on the clamp. Small blocks of soft wood are ideal for this purpose. This is a good procedure to follow in all clamping operations which involve quality work. The size of C-clamps is designated by the maximum scope between the screw swivel and the jaw.

The wooden HANDSCREW clamp is limited in both scope and pressure. Always keep the jaws of the handscrew clamp parallel to each other. Tightening this clamp with the jaws cocked will bend the spindles and damage the jaws. Never use anything but your hands to tighten the spindles. Keep the jaws well varnished to protect the wood from damage and varying moisture conditions. The size of a handscrew clamp is designated by the length of the jaw in inches; sizes range from 6 to 18 inches.

The steel BAR CLAMP applies very strong pressure and can be set to a very wide scope by moving the ADJUSTABLE HEAD outward. The size of a bar clamp is designated by the length of the bar in feet; sizes range from 2 to 8 ft.



29.16
Figure 7-34.—Working drawing of a sawhorse.



29.11:133.70
Figure 7-35.—Common woodworking clamps.

Remember that the handtools described above are just a few of those used by the SEABEE Builder. There is no doubt that, during your assignment with the SEABEES, you will be seeing or perhaps using other tools which were not covered here. If you see one with which you are not familiar, do not hesitate to ask an experienced Builder what it is and what it is used for. This is the best way of learning about different tools, especially if you do not have the chance to use them. Generally, maintenance and care of most handtools are basically the same. The main thing is: ALWAYS USE A TOOL FOR THE PURPOSE FOR WHICH IT IS DESIGNED. Following this rule will not only develop professionalism, but will also protect the handtools from abuse and damage.

It is recommended that you study appropriate sections in Basic Handtools, NavPers 10085 (revised), in order to learn more about carpentry tools and equipment not covered in this training manual.

Portable Power Tools

In heavy timber construction (explained later in this chapter), various portable power-driven tools are commonly used where cutting and boring operations are required. These power tools include chain saws, circular saws, and wood borers.

The CHAIN saw is a portable power device with the saw teeth arranged on a flexible steel chain-like belt. A special advantage of the chain saw is that it cuts well in the vertical or horizontal positions, as well as at an angle. Chain saws commonly used at your activity will probably be pneumatic or gasoline engine-driven types. A gasoline engine-driven type is illustrated in figure 7-36. This is a good tool for cutting ordinary size timbers and piles.

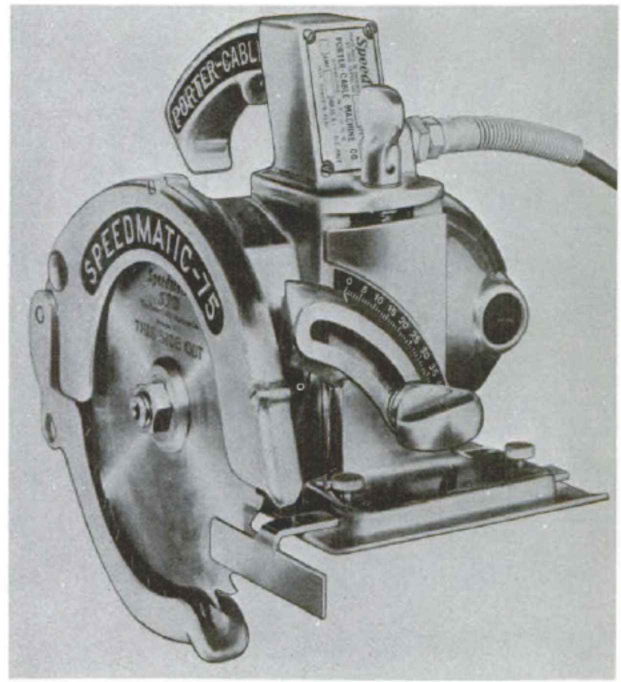
For heavy timbers, a two-man chain saw is required. A two-man chain saw can handle logs or timber up to 36 inches in diameter. It is held by two grips; one grip is attached to the motor end of the saw and the other at the end of the saw frame. The saw is held against the tree, timber, or pile to be cut, and only light pressure needs to be applied. When cutting logs the weight of the saw provides the necessary pressure. The chain containing the teeth rotates in one direction only. The saw cuts towards the power end of the saw; care must be taken to position the chain properly.

Timbers up to about 4 inches thick may be cut with portable power-driven CIRCULAR SAWS like the one shown in figure 7-37. A saw of this type may be either electric or pneumatic; the one shown in the figure is electric.

Heavy timbers are often bored with portable power-driven WOOD BORERS like the one pictured in figure 7-38. A wood borer may be either electric or pneumatic; the one shown being used in figure 7-38 is pneumatic.

As a safety precaution, do not wear loose fitting clothing when working around a power-driven tool. During operation, it is good practice to have persons other than the operator keep a safe distance away from these power tools.

29.132
Figure 7-36.—Gasoline engine-driven chain saw.



29.133(44)
Figure 7-37.—Portable electric circular saw.

When you are assigned to projects on which power tools are used, the Builder may often depend upon you to see that the tools are properly cleaned after use and returned to their proper place of storage. A main point to remember here is to make sure the tools are blown free of sawdust before putting them away. It is also good practice to check saw teeth for dullness and breaks. When saw blades become dull, they should be removed and sharpened before being stored. For electric tools, check the cords and plugs for possible damage. The key to efficiency in storage is to have a place for each tool and return each tool to its place. A large chest will probably be provided for storage of the chain saw; see that it is kept in this chest when not in use.

Chain saws, circular saws, wood borers, and other power tools and equipment are produced by different manufacturers. Bear in mind, therefore, that the operation and maintenance requirements for a particular type of tool (such as a chain saw) may not be exactly the same as for a similar tool produced by a different

29.410
Figure 7-38.—A portable power-driven wood borer being used by SEABEES.

manufacturer. If your duties involve the maintenance of power tools, make sure you study the manufacturer's manual and follow the instructions given.

CARPENTER SHOP TOOLS

If you are interested in striking for the Builder rating, working in the carpenter shop will give you a good opportunity to learn from experienced Builders about operations performed by this shop.

Boxes, crates, and other containers are fabricated by the carpenter shop, when the battalion is preparing for movement. Shop personnel also fabricate forms for concrete work, trim molding, and provide millwork (such as windows, door frames, or other items) which can be made more easily in the shop than on the job.

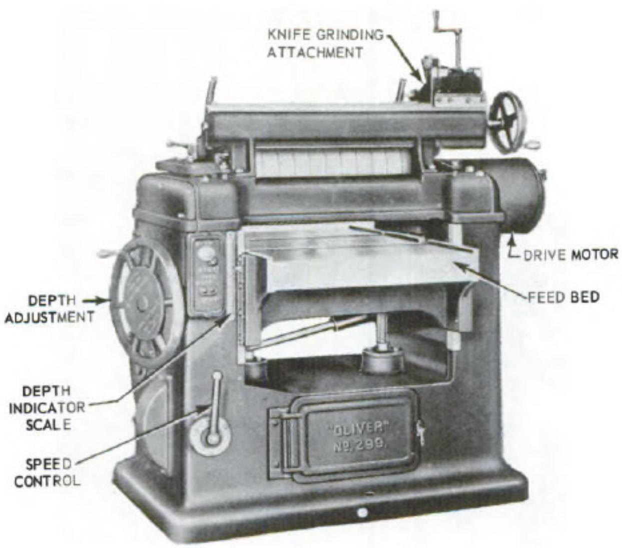
In this shop, wood can be quickly and firmly glued, doweled, or joined into place. For success in joining pieces of wood together, workers must be familiar with the various cuts and joints and where each is used. A thorough knowledge of woodworking cuts and joints is needed in constructing small items (for instance, index boxes or shipping crates), as well as large items.

The carpenter shop generally is equipped with numerous types of tools and equipment which can be used to saw, plane, carve, and turn wood to any desired shape.

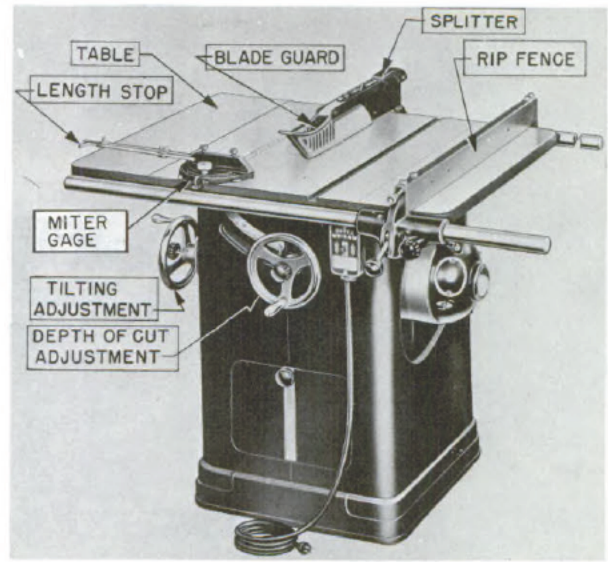
As a Constructionman, you may not actually operate any of the power tools available in the carpenter shop. But, in this shop—as in fieldwork—you may often be working in the immediate area where power tools are being used, and there are various safety precautions which you should observe under such conditions. Some of the major safety precautions you should follow are given later under "Power Tool Safety."

A SURFACE PLANER, also called a SINGLE SURFACER, is shown in figure 7-39. This machine surfaces stock on one face (the upper face) only; double surfacers, which surface both faces at the same time, are used only in large planing mills.

The surfacer cuts with a cutterhead like the one on the jointer. But, on the single surfacer the cutterhead is located above, instead of below, the piece. The piece is fed through by power-driven rollers, and the part adjacent to the cutterhead is pressed down against the feed bed by a couple of members called the chip breaker (just ahead of the cutterhead) and the pressure bar (just behind the cutterhead).



29.135
Figure 7-39.—Single surfacer.



29.136
Figure 7-40.—Tilt-arbor bench circular saw.

If true plane surfaces are desired, one face of the stock (the face which goes down in the surfacer) must be trued on the jointer before the piece is fed through the surfacer. If the face that goes down in the surfacer is true, the surfacer will plane the other face true.

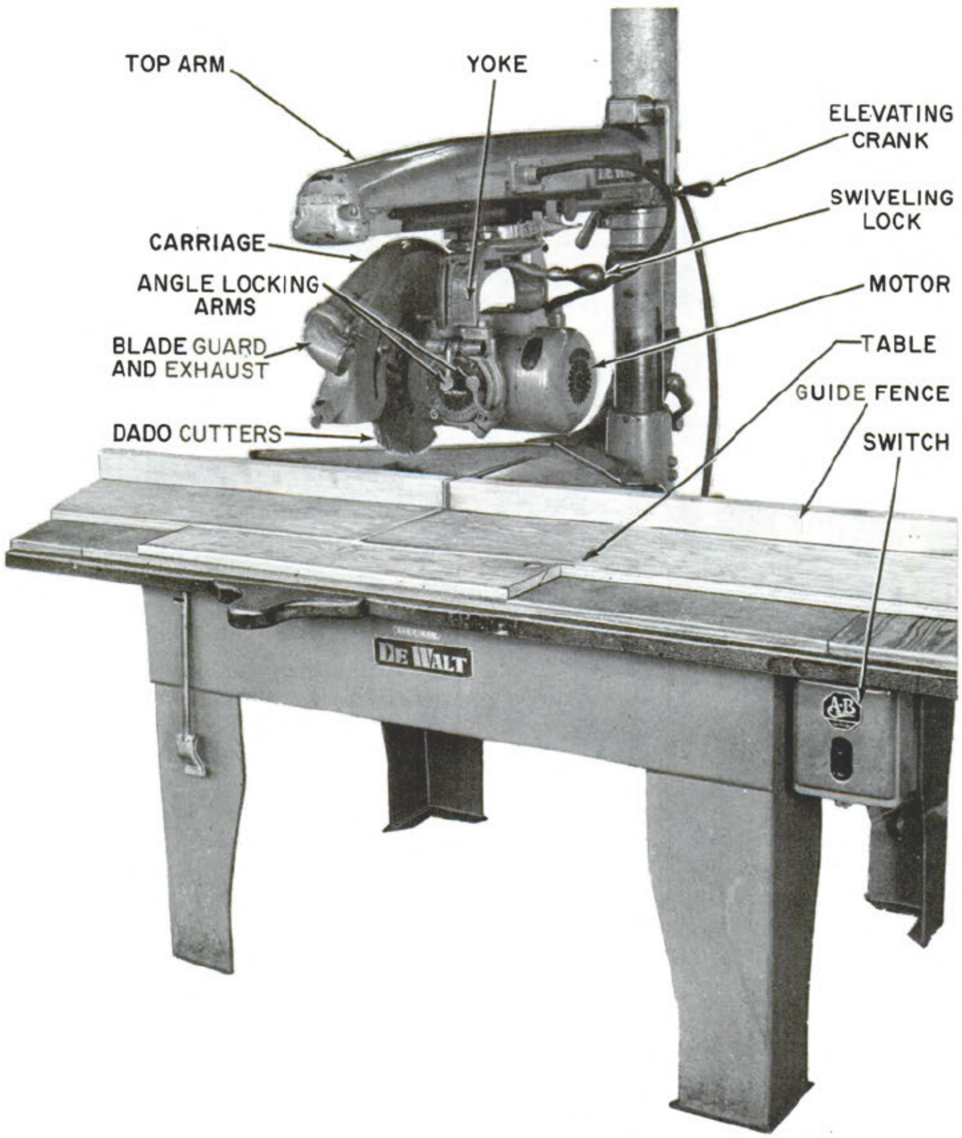
Mechanical cutting tools frequently used in carpenter shops are the CIRCULAR SAW and the BANDSAW. A family of circular saws is available, but the most commonly used are the tilt-arbor bench saw, and the radial arm saw.

A TILT-ARBOR BENCH SAW is shown in figure 7-40. It is called a tilt-arbor saw because the saw blade can be tilted for cutting bevels and the like by tilting the arbor. The arbor, by the way, is the shaft that the blade is mounted on. In earlier types of bench saws, the saw blade remained stationary and the table was tilted. A canted (tilted) saw table is hazardous in many ways, however, and most modern bench saws are of the tilt-arbor type.

A circular saw is a handy tool for ripping, crosscutting, and cutting angles and bevels. The circular saw shown in figure 7-40 has a crankwheel at the left which can be turned to change the angle of the saw blade with the table top. The angle is indicated on a scale at the front. The crank shown at the front of the saw is turned to change the depth-of-cut adjustment of the blade. Locking knobs on each crankwheel are provided to secure the adjustment once it is established. The rip fence, shown at the right, on the saw table can be used on either side of the blade for ripping, rabbeting, grooving, tenoning, and dadoing. The rods attached to this gage at the left serve as a guide for length in cutting duplicate pieces.

The blade safety guard, secured at the back center of the table, covers the blade and provides a kerf splinter for ripping. The guard prevents the kerf from closing and jamming the blade. Another mechanism in this assembly prevents pieces from being kicked back toward the operator by the fast-moving blade.

A RADIAL ARM SAW is shown in figure 7-41. The motor and arbor are pivoted in a YOKE which can be swung in any direction. The yoke slides back and forth on an ARM (or OVERARM) which can also be swung in any direction. These arrangements make the radial saw adaptable to almost any conceivable type of saw cutting, as indicated in figure 7-42. When equipped with a GROOVING HEAD, the saw can be used for GROOVING AND RABBETING; when equipped with a SHAPER HEAD, it can be used as a SHAPER; then, when equipped with a ROUTER BIT, it can be used for ROUTING. In short, the radial arm saw is just about the most versatile power cutting tool in the carpenter shop.

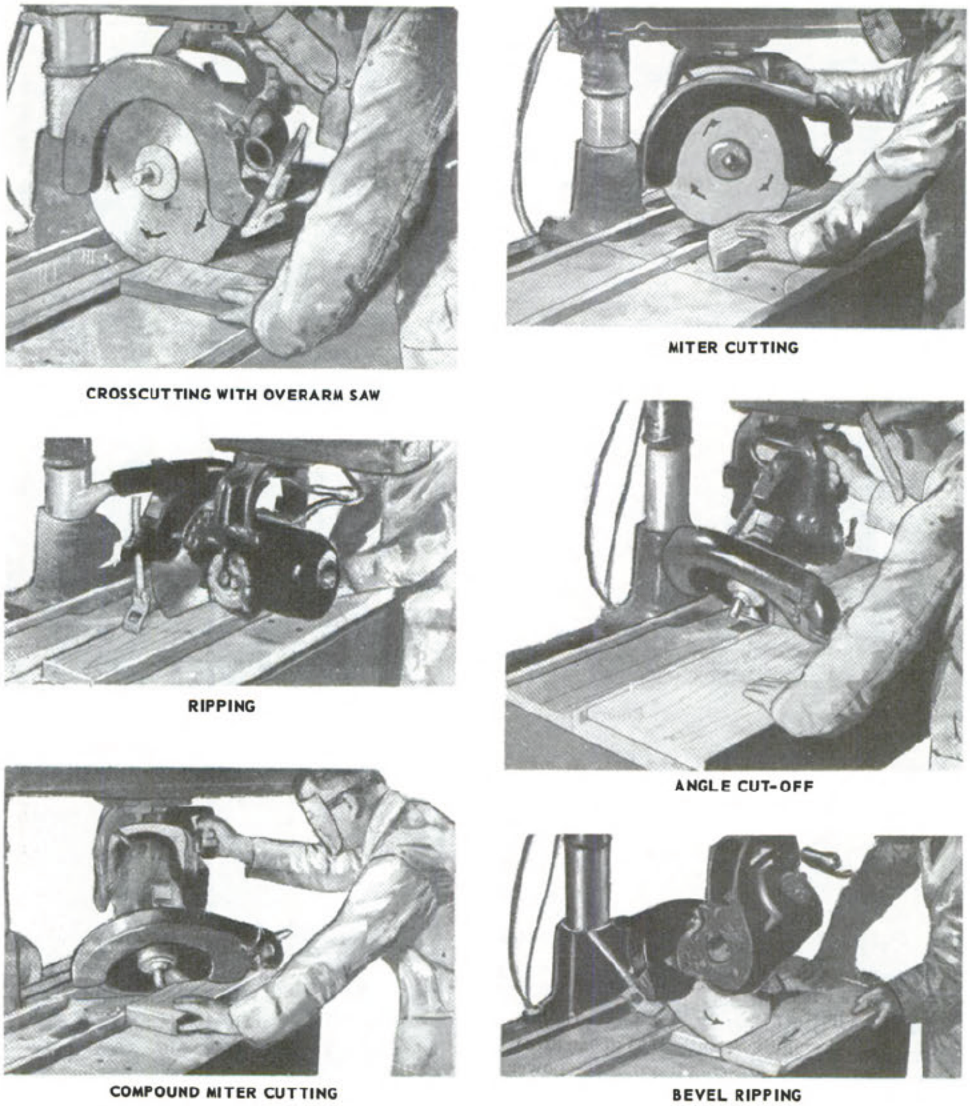


44.62(133E)A
Figure 7-41.—A radial arm saw.

A small BANDSAW is shown in figure 7-43. While the bandsaw is designed primarily for making curved cuts, it can also be used for straight cutting. And, unlike the circular saws, the bandsaw is frequently used for freehand cutting.

The bandsaw has two wheels on which a continuous narrow saw blade or BAND turns, just as a belt is turned on pulleys. The lower wheel is located below the working table; it is connected to the motor directly or by means of belts or gears and serves as the driver wheel. The upper wheel is the driven wheel.

Another important power tool is the JOINTER. This tool is frequently used for such purposes as smoothing and straightening the surfaces of boards and for cutting rabbets and bevels. A 6-inch jointer is pictured in figure 7-44.



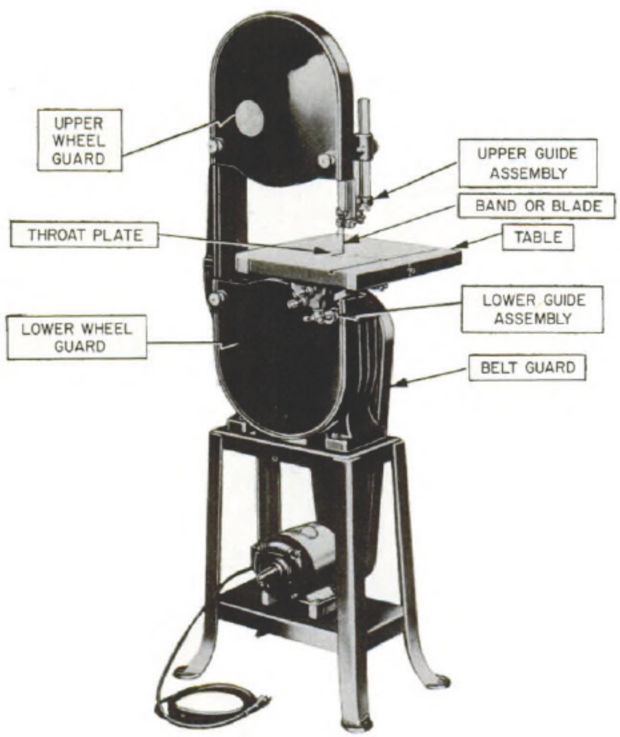
44.62
Figure 7-42.—Saw cutting with the radial arm saw.

A principal working part of the jointer is the revolving round CUTTERHEAD, which holds the two or more KNIVES that do the actual cutting. The knives remove controlled amounts of wood from the stock as it is pushed along the front (infeed) bed, across the cutterhead, and on to the back (outfeed) bed.

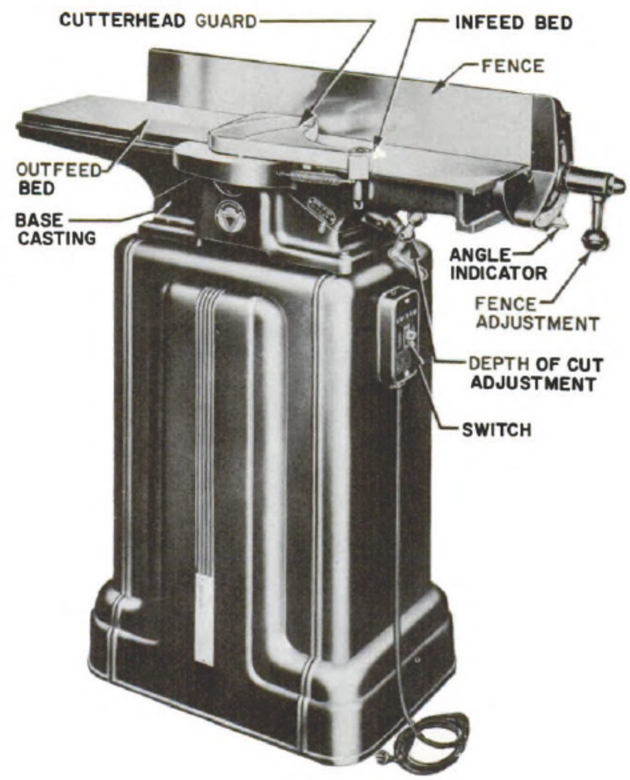
The knives of the cutterhead must be perfectly aligned and the center of their circle of travel must be perpendicular to the longitudinal axis of the outfeed bed. The infeed bed can be adjusted up and down with a handwheel or crank to control the depth of cut. Maximum depth-of cut is usually three-sixteenths of an inch, but such heavy cuts are seldom made.

Each jointer has a FENCE which is used to guide the work and to maintain the desired angle. It can be used as a guide for cutting chamfers and bevels. When the jointer is used for truing up and squaring edge and face surfaces, the depth-of-cut adjustment is set for a cut that is seldom more than one-sixteenth of an inch—and often much less.

The size of a jointer is designated by the width in inches of the cutterhead. Jointers range in size from 4 inches to 36 inches; however,



29.137
Figure 7-43.—A small bandsaw.



29.138
Figure 7-44.—A 6-inch jointer.

large sizes are seldom found in Navy carpenter shops.

At most activities, the carpenter shop will likely be provided with one or more SANDING MACHINES. These may be portable or semi-portable type machines, rather than the heavy-duty sanders often used in production shops.

A portable belt sander like the one shown in figure 7-45 is handy for almost any kind of sanding job. This sander can speed up work when sanding interior wood trim, furniture, and similar work. In using a portable belt sander, the operator does not have to press down on the machine or "ride it"—the weight of the machine exerts enough pressure for proper cutting.

Some shops may have a small, bench-type belt sander which is similar to the portable machine, except that its use is limited because the work must be brought to it. Such a machine may have a sanding disk attachment which is especially useful for rounding corners.

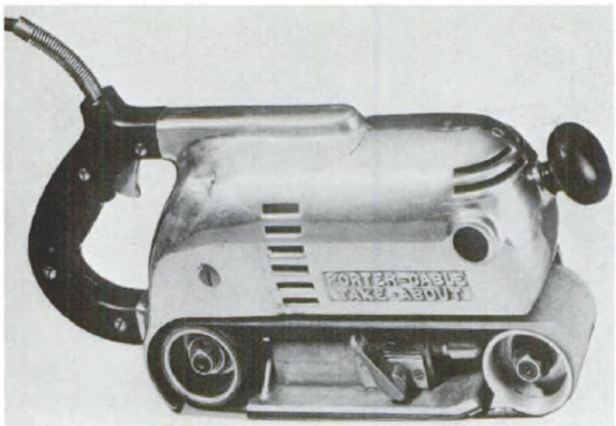
Safety is very important when working around power machines and must not be taken for granted. Familiarize yourself with the precautions listed here; bear in mind, also, that other safety measures of equal importance can be learned through further study and work experience.

When you are working around power machines in use, do not wear loose garments, gloves, or neckties which might be snagged in moving machinery parts. When wearing a long-sleeved shirt, it is recommended that the sleeves be rolled up tightly to avoid the same danger.

Hands must be kept away from moving cutting mechanisms. They must also be kept out of any position in which they might drop on the cutting mechanism if the piece should happen to "kick back."

An individual who is operating a power machine should be spoken to only when absolutely necessary. If the operator is feeding stock, his attention must not be distracted until after the piece has been fed through and recovery has been made.

Do not stand directly behind or in line with the circular saw when it is in operation. If you are in line and the saw kicks back a piece of



29.139
Figure 7-45.— Portable belt sander.

material as a result of binding, you might suffer a serious injury. Never reach across or lean over or toward the saw while it is running.

If you are working around a bandsaw in operation, keep your fingers away from the moving blade. And don't lean on the table at any time.

The saw tables and the feed beds of the jointer should be cleaned off frequently to remove scrap wood, sawdust, and other such matter. If you are asked to assist in this operation, make sure the machine is STOPPED and unplugged from its power source before you do any cleaning. Remember, also, to use a brush or a piece of wood to remove the scrap material.

When sanding machines are in operation, wear goggles or masks for protection; wear them also while cleaning up afterwards. As a further precaution, make sure to keep your hands and other parts of your body from coming into contact with the abrasive surface of the sander.

Do not tamper with any power equipment which does not come within your regular duties unless you have received permission and instructions from your supervisor.

One of the main factors that makes for safety in shop work is good housekeeping. As a Constructionman, much of your time may be spent in keeping the shop in safe, clean working order. Here are a few pointers on doing this.

Make a special effort to keep materials and equipment out of the aisles. See that tools and other equipment are returned to their proper place of storage after use.

Deposit trash and scrap in proper waste containers; empty containers as often as necessary. Keep the shop floor free of tripping hazards such as scrap lumber, pieces of wire, soft drink bottles, and so forth. See that sawdust, shavings, and other such matter that get on the floor are cleaned up promptly.

Dirty and disorderly conditions may result in serious accidents, as well as cause fires. Take pride in your place of work. Keep it clean! Keep it safe!

LIGHT STRUCTURES

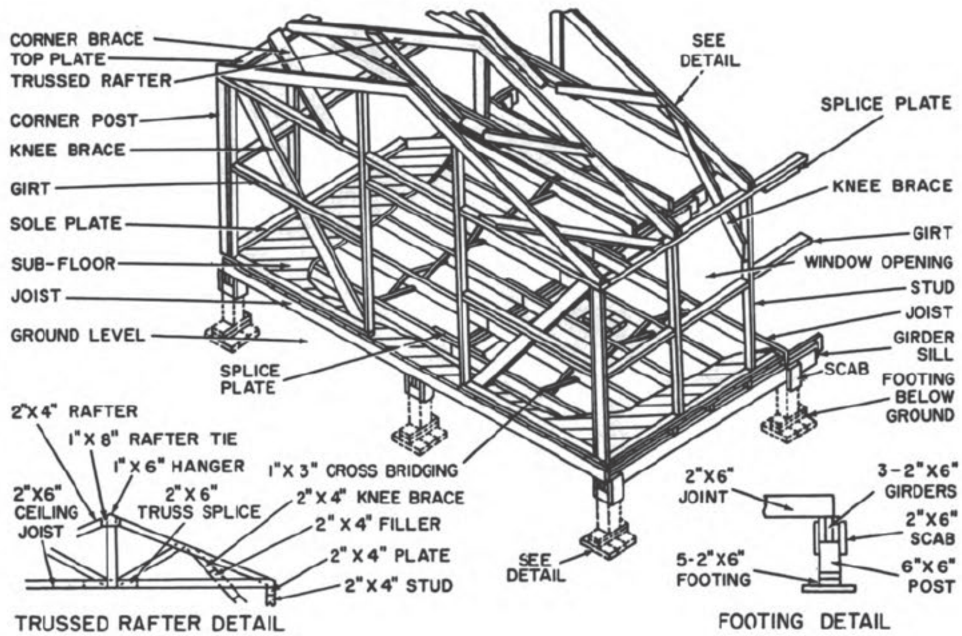
In peacetime, as well as during war and other emergencies, Builders have plenty to do in the way of building new structures and in making repairs to existing structures. Buildings of any type, generally, are referred to as LIGHT STRUCTURES. These include buildings for use as warehouses, repair shops, barracks and so on. (Those structures which are referred to as HEAVY will be described later.)

LIGHT FRAME CONSTRUCTION

A FRAME structure is one in which the frame consists principally of load-bearing members made of structural lumber, structural steel, or other strong construction materials. Framing is a skeleton, or framework, upon which the covering is to be placed. Just as the bony skeleton is the basic supporting structure of the body, so the framing of the structure contains its fundamental strength. The framing of a building includes the floor framing, wall framing, and roof framing.

Wood Frame Structure

A drawing of the basic framework of a WOOD FRAME building is shown in figure 7-46. This drawing portrays the framework of temporary buildings that the SEABEES generally build at advanced bases overseas. The different parts of the framework are indicated to give you an idea of their positions and the terms used to describe them. Basically, figure 7-46 shows the framework of the SEA huts described earlier in this chapter. Another type of barracks built overseas is the two-story building shown under construction in figure 7-47. Here, you can see the Builders installing a section of the side wall. Some of the members illustrated in figure 7-46,



29.411
Figure 7-46.—Sectional view of a light frame building.

you will recognize in figure 7-47, as they are actually constructed.

Steel Frame Structure

A STEEL FRAME structure is a framework of structural steel members. Construction of a framework of structural steel involves two principal operations, namely FABRICATION and ERECTION. Fabrication involves the processing of raw materials to form the finished members of the structure (see chapter 9). Erection involves all the processes of rigging, hoisting, or lifting members to their proper places in the structure, and making the finished connections between members; this is the type of work that the SEABEES are generally concerned with when it comes to steel frame structures.

Many of the buildings erected at naval activities are prefabs—that is, prefabricated structures. The steps followed in erecting prefabs have been thought out in advance and greatly simplified. The parts and procedures are standardized. Too, the prefab structures are shipped complete with a manufacturer's instruction book, plus detailed plans, on how to do the job.

One well-known type of prefabricated structure is the ARCH-RIB HUT, commonly known as the QUONSET HUT or simply QUONSET. (See figure 7-48.) Quonset huts came into use during World War II and were used for purposes ranging from housing of personnel to storage of supplies and equipment. They are still commonly used. In size, quonsets are 20 by 48 feet or 40 by 100 feet.

Another type of prefabricated structure which is widely used by the Navy, at present, is the RIGID FRAME steel building, one type of which is shown in figure 7-49. As with arch-rib buildings, rigid frame steel buildings also come in sizes of 20 x 48 feet and 40 x 100 feet. The rigid frame steel building is a preengineered structure and quite an improvement over the arch-rib building shown in figure 7-48.

Rigid frame steel buildings are available under various trade names (usually the name of the manufacturer or inventor of the building). The two commonly used by the Navy are the BUTLER and the PASCO buildings. Their basic framework are very similar except for the various openings and the shapes of the walls and roof. You will be hearing more about these buildings as you stay longer with the SEABEES.

29.412
Figure 7-47.—Builders constructing a two-story temporary barracks.

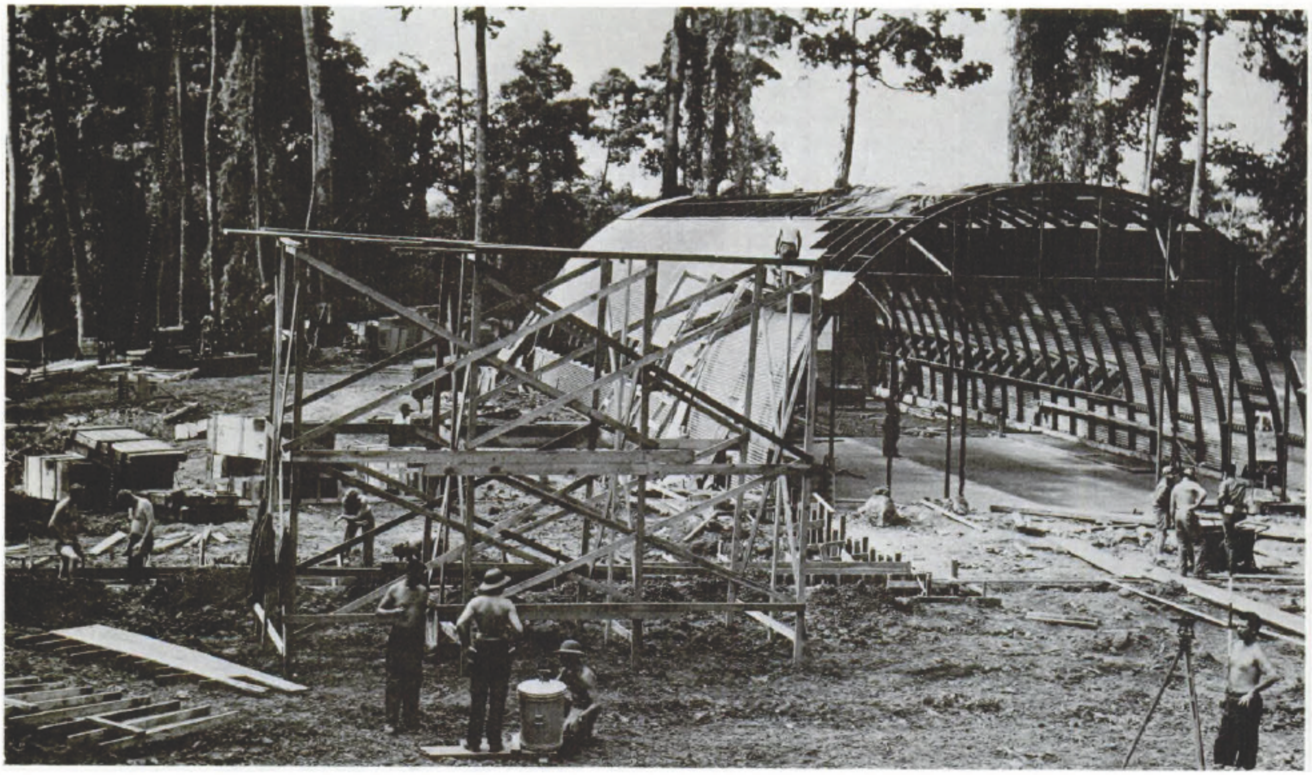
Builders may be required to erect the 20 x 48 ft. rigid frame building, but erection of the 40 x 100 ft. building is generally done by the Steelworkers. The Builders, however, are responsible for preparing all foundations and forms, and also for installing partitions, if required.

As a CN, your duties in erecting arch-rib or rigid frame buildings will consist mainly of helping to carry and place materials. Erecting these buildings is not a complex job, but it will become difficult or impossible if the proper sequence of erection steps is not followed. Your crew leader will direct the assembly operations and, as usual, you must be alert and observe all safety procedures.

BUILDING FORMS

Varied types of building FORMS are frequently used where parts of a structure will be made of concrete; and construction of these forms is a job for a qualified carpenter. Simply stated, the forms provide an enclosure in which the fresh concrete is placed. Most forms for concrete work are constructed of wood, although sheet metal and fiberboard are also used.

An assembled WALL FORM is shown in figure 7-50. Form boards (also known as sheathing), ties, and other details regarding construction of this form are shown in the illustration. It is especially important that forms for walls, foundations, and other structures which hold a mass of concrete be strongly and rigidly constructed. Braces are used to keep forms in alignment and they help withstand the pressure of the concrete's weight. Wales, studs, sheathing, and most importantly ties must withstand all pressure without transferring any to the braces. The need for strong construction is understandable considering that wet concrete mix weighs about 150 pound per cubic foot.



29.413

Figure 7-48.—Builders erecting a quonset (arch-rib) hut while SEABEES were building an airstrip in the Philippines.

The COLUMN FORM is another type of formwork used in concrete construction. Column forms are used to make concrete posts to support structures and are frequently employed to reinforce side walls. One type of column form is shown in figure 7-51. You will probably see various other types of building forms used on different projects involving concrete construction; further information on formwork is given in chapter 8.

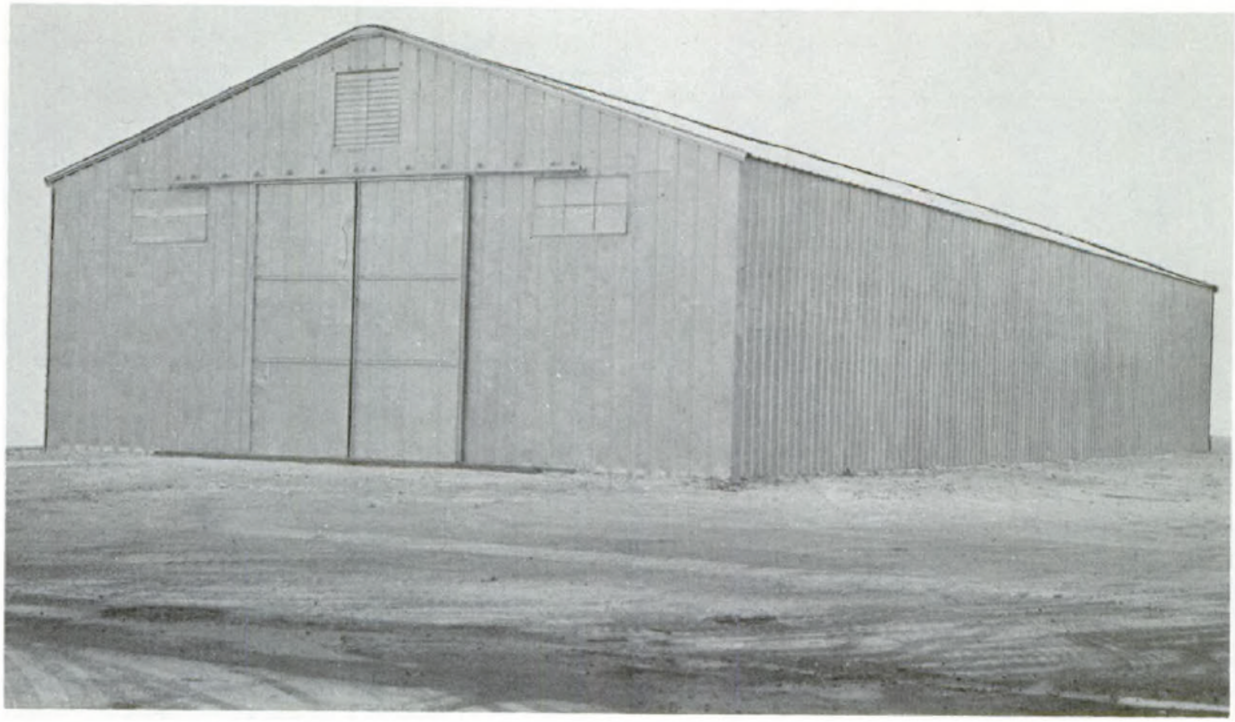
There are many ways in which the CN can assist the Builder in construction jobs involving light structures. At first, though, your duties will probably consist mostly of basic tasks such as handling and storing materials, preparing form materials and some mixing of concrete by hand, cleaning tools and equipment, and general housekeeping.

Information on proper storage of lumber was given earlier in this chapter. Make it a point to know the kinds of materials used in your work. Make sure also that you know how to handle materials to prevent damage to them or possible injury to yourself or coworkers.

Forms for concrete work often are built in sections. An experienced Builder will likely construct the forms, but you will probably assist the crew which will lift and move them to the location where needed. You may also assist in cleaning forms, applying form oil, and performing other duties relating to concrete construction as described in the next chapter.

Cleaning tools and equipment after use is an important factor in construction work. Proper maintenance and storage of tools will help keep them in peak operating condition and will help increase safety on the job.

Safety in light construction work also requires careful attention to housekeeping. See that boards with protruding nails are not left lying around where someone might get hurt on them. Make sure you remove or bend down nails in lumber that others are going to handle.



127.121X
Figure 7-49.—A rigid frame steel building, 40' x 100' type.

When you carry a length of lumber or other such object on your shoulder, tilt it upward to clear the head or body of another person.

If you have occasion to climb ladders, check your shoes to make sure they are free from grease or slippery substances. Watch for broken rungs while climbing. Face the ladder while climbing up or down.

Among other things, see that loose tools and materials are not left lying around; pick up pieces of scrap lumber; watch for falling ladders; and keep the area free of trash or other material that might cause accidents or fires.

HEAVY WOOD STRUCTURES

The Builders play an important role in the construction and repair of heavy structures made of wood. (Many heavy structures are made of steel, but these are the primary concern of the Steelworkers.) Wooden wharves, piers, and cofferdams are typical examples of waterfront structures constructed by SEABEE Builders.

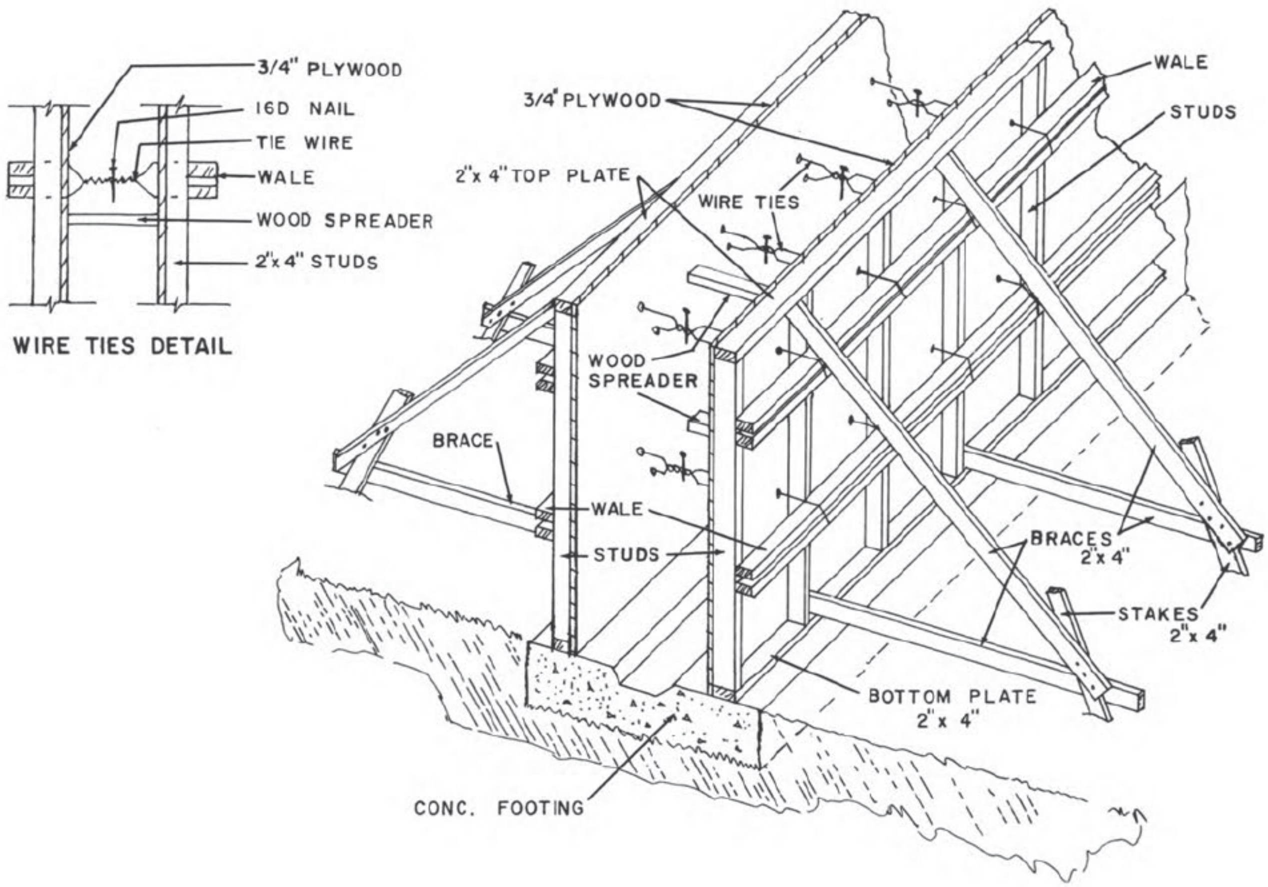
In addition to waterfront structures, Builders also erect wooden bridges for getting men, materials, and equipment across ravines, marshes, or water. They erect towers for heavy structures such as steel water tanks; and, when the water tank is to be made of wood, they construct that also.

A wharf is a structure alongside which ships may lie to load or unload their passengers and cargoes. A pier is a structure which projects out into the water from the shoreline and serves the same purpose as the wharf.

In the building of a timber pier, timber piles are driven to form "bents," a pile bent consisting of two or more piles, cut to proper elevation, and connected by a timber "cap" across the tops. Lengthwise timber "stringers" are laid from cap to cap, and deck planking is fastened to the stringers.

A COFFERDAM is a watertight enclosure from which the water is pumped to expose the bottom of the river or sea to permit work there.

Cofferdams may be constructed of wood or steel sheet piling. The simplest form of wood sheet piling consists of wood planks driven side



29.414
Figure 7-50.—Wall form with wales and braces.

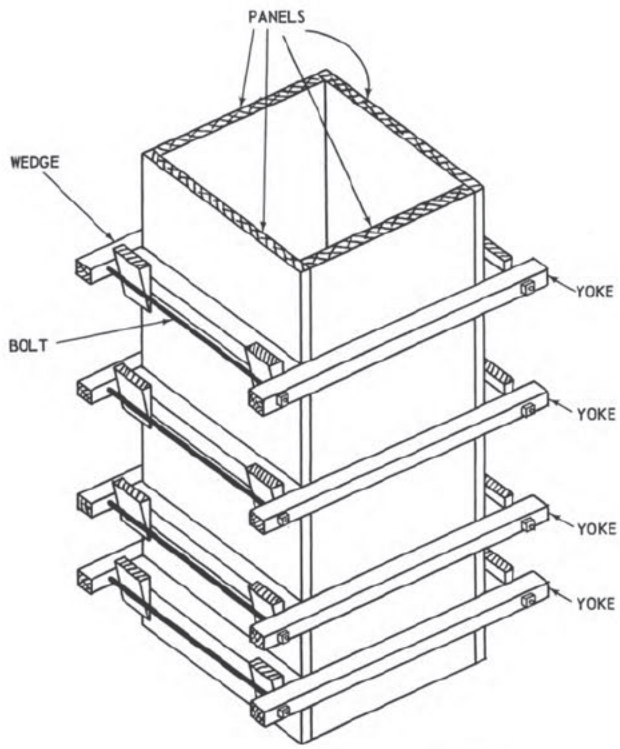
by side. This structure will hold back earth, but it will not keep out water.

Highway and railroad bridges are required at numerous naval activities, either within the activity or on access roads and connections adjacent to it. Bridge construction may involve other types of work—in addition to the actual bridge erection—such as pile driving, construction of cofferdams, and placing concrete.

Bridges often are made of steel, and such construction is handled primarily by Steelworkers. However, wood bridges are sometimes provided on secondary roads, and may be necessary on main roads when shortages of critical materials prevent the use of steel. Wood highway bridges may be surfaced with bituminous pavement, may have composite decks of timber and concrete, or may have steel hangers.

Figure 7-52 shows a wood stringer bridge in the process of construction. A wood stringer bridge is one in which the wood stringers (longitudinal members between supports), flooring, and treads are supported either by timber trestle bents or pile bents. Timber trestle bents are a simple form of intermediate support. They can be used wherever the bottom is firm enough to support the load, provided the depth or scouring action of the water is not too great. Where timber trestle bents cannot be used, pile bents are employed.

Builders are responsible for erecting towers to support steel water tanks such as the one shown in figure 7-53. The Steelworkers are responsible for assembling the tanks. If the base camp to be supplied with the water is located near a hill or mountain that is high enough to meet the water head requirements,



45.472
Figure 7-51.—Column form.

the water tank may simply be constructed setting on a concrete pad. The concrete pad is poured in-place by the Builders.

Generally, the engineer will compare the cost of erecting the tower with the cost of running a pipeline from the hill top. Other considerations are expediency and security requirements.

As a CN, you should be able to perform a number of different duties in operations concerning construction of heavy wood structures. The nature of your duties may depend on the type of structure being erected and the degree of skill required. Assuming that you are a beginner, it is likely that your duties will include the transportation, storage, and handling of materials. While most of this work is done by power-driven equipment, such as trucks, cranes, fork lifts, and so on, much of this work still is done by hand. Picks, shovels, wheelbarrows, and the like are by no means obsolete. Despite the present-day trend towards mechanization, power-driven equipment such as cranes is not always readily available; furthermore, power equipment is subject to unexpected breakdowns the same as other equipment. These and other such factors make it necessary at times that Builders rig their own hand-operated hoisting equipment. The more common types of hand-operated hoisting devices include the gin pole, shears (also called A-frame), and tripod.

The basic hand-operated hoisting device is the TACKLE or PURCHASE, consisting of a line or wire called a FALL, reeved through one or more BLOCKS. Basic information on line wire, and various types of purchases is presented in chapter 9 of this training manual.

Many materials are used in heavy construction. Complete instructions on various methods and techniques used for handling, hoisting, and storing each different type of material cannot be given in this short chapter; several lengthy chapters would be required for detailed coverage. Only a brief treatment of materials handling BY HAND (as opposed to power equipment such as cranes) is presented here. And, in our discussion, special attention is given to safety.

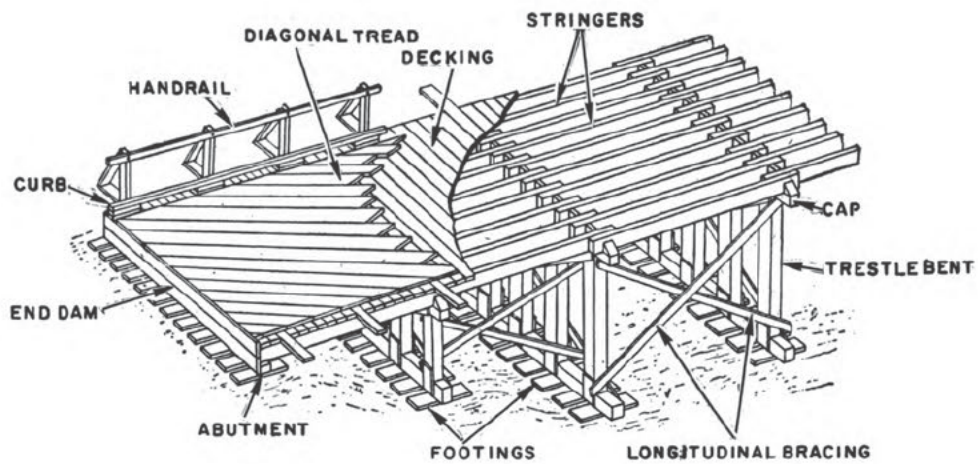
From the standpoint of personal protection, all workers engaged in materials handling should wear approved safety shoes. The wearing of sandals, open-toe shoes, or thin-soled shoes should NOT be allowed. Foot guards and leg guards should be worn when the nature of the material being handled indicates the need for such protection.

Gloves should be worn by men engaged in carrying, lifting, or moving objects which are sharp, spiky, splintery, or otherwise hazardous to the bare hands. Men handling acids, caustics, or strong solvents must wear suitable approved gloves, rubber aprons, acid-resistant boots, and goggles or face shields.

All personal protective equipment must be issued clean, and it must be always cleaned after using. Finger rings should not be worn by men engaged in materials handling.

Personnel with existing hernias, or with a history of repeated back-strain, should report the fact to their superiors. Such personnel should not be assigned to hand-handling of heavy materials.

In hand-lifting, it is especially important that workers use the proper method of lifting heavy objects. Lifting should be done with the legs and not with the back. The way to lift a loaded wheelbarrow by this method is explained in chapter 8; the method is similar for lifting heavy objects from ground level. (In chapter 8, some safety precautions to follow when using wheelbarrows on construction jobs are also given.)



29.130
Figure 7-52.—Wood stringer bridge under construction.

Before lifting a heavy object, inspect it carefully for sharp corners or edges, protruding nails, and other factors likely to cause personnel injury. Also, check the path you will follow in carrying the object and remove all obstructions (if any) that might cause you to trip or fall.

In many instances, it may be wise to make a trial lift of the object to determine if you can lift it without strain. When an object is too heavy to lift by yourself, get someone to help you.

When setting down an object, the technique is to bend your legs and the trunk of your body at the waist. Here, again, the idea is to make the leg muscles, rather than the back muscles, do the work.

PAINTING

Painting serves many useful purposes at naval installations. A chief purpose of painting is for the preservation of equipment, buildings, and other structures. As a preservative, paint protects materials from various forms of destruction, such as rot, decay, rust, and other effects of the weather. Paint also is commonly used as a decoration for the interior of homes and buildings. While providing decoration of interiors, paint often serves other useful purposes; for instance, by making the walls and ceiling of the building more sanitary and improving vision by the use of light colors in dark rooms. These and other benefits which could be cited go to show why painting at regular intervals is considered a practical means of keeping structures and equipment in good condition.

To become an expert painter requires considerable experience and know how. A skilled painter must be familiar with different types of paint and paint materials, paint composition, and methods of preparing various types of surfaces to be painted. A well-qualified painter also must know various methods of painting, techniques of applying paint, use and care of equipment, and safety precautions for all phases of his work. There are other essential qualifications, but those mentioned are enough to show that the subject of painting is broad in scope. Therefore, this discussion must be limited to just a few selected topics on painting.

As a Constructionman, you will assist in preparing surfaces for painting. You will be under the supervision of an experienced petty officer. Carefully observe the method or means used to prepare the surface properly. You may also find information on surface preparation, applying paint and varnish by brush, and care of paint brushes in Basic Handtools, NavPers 10085-A.

PAINTS

There are many different types of paint. A main factor in the selection of paints is to know the type (or types) of paint suitable for the kind

29.415
Figure 7-53.—A 250-barrel steel water tank on a 35-foot tower.

of surface to be painted. For example, a paint designed for exterior wood surfaces would not be suitable for interior surfaces of a building.

Paints generally used for interior walls and ceilings range from high quality oil paints to low cost water-thinned paints. Oil paints are available with a flat, semigloss or high gloss finish. Water-based (latex) paints are made by mixing casein powder with water. These paints are suitable where a low cost finish is desirable. At present, however, due to breakthroughs in chemical technology, water-based paints are comparable to most other paints. Water-based paints are getting popular for use as preservatives of both interior and exterior walls. Their finishes have greatly improved and they are as durable as the other paints on the market; besides, water-based paints are cheaper, easier to apply, and easier to clean.

Cement-base paints or oil-base paints may be used for painting concrete, stucco, and brickwork. The cement-base paints come in powder form and are prepared by mixing with water. Regular oil-base paints, such as house paints, may be used in painting masonry. With these paints, however, a proper sealing or priming coat should first be applied to seal the pores of the surface. Oil-base paints are also available in which materials for sealing the surface are inherent in the paint. When these paints are used, a priming or sealing coat is not necessary.

You may be interested to know that all paints consist of a solid (the pigment) in a liquid (the vehicle). The PIGMENT is a very finely divided solid, which furnishes the paint its power to cover and color a surface. The VEHICLE makes it possible to spread the pigment over the surface, and upon drying binds the pigment particles to the surface and to one another. As a rule, both pigment and vehicle are mixtures.

VARNISHES

Various grades and kinds of varnishes are available. Good quality varnishes are made of resin or copal gum dissolved in linseed oil and turpentine. For satisfactory results, a varnish should be used only for purposes for which it is intended. An interior varnish, therefore, should not be used on exterior surfaces exposed to the weather.

Two common types of varnishes are: oil varnish and spirit varnish. OIL varnish will dry or harden partly through evaporation and partly through oxidation. This varnish should be allowed plenty of time to dry before another coat is applied.

SPIRIT varnish is mixed with a highly volatile vehicle, usually alcohol. It therefore dries entirely by evaporation.

In SHELLAC the basic substance is a flaky material secreted by an insect. The vehicle in shellac is also alcohol or some other highly volatile liquid.

LACQUER is a spirit varnish based on cellulose nitrate, and usually colored with a color pigment or by chemical process.

Varnish is used as a vehicle and also as a separate coating. As a vehicle it is found chiefly in primers and enamels where hardness, gloss, water resistance, and similar properties are desired.

PRESERVATIVES

In some instances, wood may be kept from decaying by coating it or impregnating it with a preservative, such as creosote or zinc chloride. While these preservatives are not paints, they do have a common purpose—that is, the preservation of materials.

Decay in wood results from the action of fungi, forms of plant life which grow and feed upon the substance of wood. Preservatives also protect wood against the attack of such insects as termites and wood beetles, which eat away the substance of the wood.

One type of creosote is COAL-TAR CREOSOTE. This is a brownish-black heavy oil, practically insoluble in water, distilled from coal. It poisons the food supply of termites and is very effective as a preservative for wood in contact with the ground or exposed to the weather. In some instances, the use of coal-tar creosote may not be desirable because it is dark in color, does not take paint well, and gives off a strong odor.

ZINC CHLORIDE is a salt which is forced into the pores of the wood. This preservative is colorless, odorless, and takes paint well. It is very useful for interior work, and for some exterior work.

CN DUTIES IN PAINTING OPERATIONS

When working with Builders on painting projects, you—as a Constructionman—will be called upon to perform a variety of tasks. You may be asked to prepare wood surfaces for painting, to apply paint with a brush to surfaces not requiring a high degree of skill in painting technique, to clean and store brushes and other equipment after use, and to take care of the handling and storage of paint and paint materials.

Proper preparation of a surface to be painted is just as important as applying the paint. Surface preparation may require the use of various materials such as plastic wood, putty, paint or varnish remover, and bleaching. You will also use various handtools such as a steel wire brush, hand scraper, and putty knife.

Different types of power tools are used in preparing surfaces for painting. These tools include the electric portable grinder, the pneumatic chipping hammer, and the electric disk sander. At the CN level, you might not have an opportunity to use power tools, but there is a lot you can learn by watching them in use and asking questions about their operation.

Paints and other surface coatings, such as enamels, varnishes and lacquers, are generally applied by brush, roller, or spray equipment. Painting by BRUSH is the best known and most popular method of painting. Practically all types of paint and coatings can be applied by brush on just about any type of surface—except acoustical plasters.

Various types of paint brushes are available, and each is designed for a specific kind of job. Two important factors that must be considered in selecting a brush are the type of paint or coating to be applied and the size and shape of the surface to be painted. One common type of brush is the FLAT BRUSH, which is especially practical for painting large surface areas or rough work (see fig. 7-54). Another common type is the FITCH BRUSH (also shown in fig. 7-54), which is very suitable for painting finer work such as trim, small pipes, and so on.

PAINT ROLLERS make for speed and convenience in painting and, at the same time, a smooth, even and uniform coating generally is obtained. Several different types of paint rollers are available; common types include the dip roller, cylinder-feed roller, and pressure-feed roller. Different fabrics—such as lambswool, mohair and various synthetic fibers—are used as covering for these rollers. Each fabric is best-suited for applying a particular type of paint or for painting a particular kind of surface. Extension handles, up to 72 inches long, can be

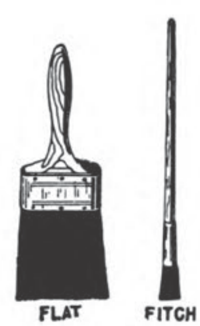


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Figure 7-54.—Paint brushes.

used with rollers for stand-up painting of high wall areas, ceilings, hard-to-reach places, and so forth. Extension handles are an advantage in that they eliminate a lot of the ladder and scaffolding work.

A paint SPRAY GUN provides a speedy and easy method of painting large surfaces. In addition, it is suitable for hard-to-reach areas, as well as porous surfaces such as acoustical plaster. Spray guns are available for all types of painting operations. Special spray heads, which permit spraying of materials that vary in consistency from very thin to very thick, can be obtained for use with the spray equipment.

Storage of Paint

Navy paints, except cement-base paints, are usually provided ready-mixed in 1- and 5-gallon containers. Cement-base paints usually come in 50-pound bags of dry ingredients, to which the water must be added in a suitable container.

Paints should be stored in a cool, dry place. Large quantities of paint in 1- and 5-gallon containers should be stored in enclosures with fireproof walls. Small quantities should be stored in properly constructed storage cabinets. Metal cabinets should be used if available; if not, cabinets should be constructed of asbestos-cement board not less than 5/32 inch thick. Bottoms and sides should be double thickness, with a 1 1/2-inch air space between the boards. Doors should also be of double thickness, with raised sills 2 inches above the bottoms of the cabinets. Doors should be provided with suitable locks, and a door should be kept closed and locked whenever paint is not being taken from or stored in the cabinet. All doors should be marked: "DANGER! FLAMMABLE! KEEP FLAME AND EXCESSIVE HEAT AWAY."

All MIXED paint must be stored in nearly filled, tightly sealed containers, to prevent skimming over, the loss by evaporation of volatile materials, and the danger of fire.

Paint cans should be stowed with the labels visible to facilitate speedy selection. It is good practice to use the oldest paints first, as paint tends to deteriorate with age. If old paint must be used with new paint, the entire lot should be blended to ensure uniform gloss and color.

Containers of stored paint should be upended about once every 3 to 4 months. The purpose of this is to prevent the pigment from settling to the bottom of the can and becoming caked, resulting in extra work when the paint is to be used.

Paint should not be left standing in open containers, as a scum will form over the surface and the paint will deteriorate due to evaporation of the vehicle. Another good practice for preventing scum formation is to turn the paint can upside down momentarily after securing the lid to create a seal.

Cement-base paints in bags must be stored in the same manner as ordinary cement. Instruction for storing ordinary cement in bags are given in the next chapter.

Turpentine, paint oils, and thinners frequently used for thinning paint and cleaning brushes are flammable. These materials, as well as paints, should be stored in sealed containers, preferably of metal.

Safety with Paints and Paint Materials

Most paints and paint materials are a fire hazard and can endanger the health of personnel. Some of the major safety precautions you should know and observe are given below.

Paint shops and mixing rooms must have adequate ventilation. There must be no smoking in paint shops and mixing rooms. "No Smoking" signs must be displayed throughout these areas.

Do not expose containers of paint to direct sunlight or to any excessive heat, smoke, sparks, or flame. Do not use lanterns, gas jets, oil lamps, or torches in the paint shop.

Some paint and varnish removers contain flammable ingredients. Therefore, these materials, like paints, should not be used around an open flame. They should not be used in confined spaces, because some of them have dangerous anesthetic properties. Avoid letting the remover touch your skin; watch out particularly for your face, eyes, and mouth. If paint or varnish remover touches the skin and begins to burn, immediately wash it off with cold water, and consult the medical officer.

All paint storage spaces must be kept absolutely free of any unnecessary combustible materials.

Buckets of sand must be kept available for absorbing spilled, leaked, or overflowed paint. NEVER USE SAWDUST FOR THIS PURPOSE.

At the end of each working day, all workbenches should be scraped with a putty knife and cleaned with thinner. All drip pans should be drained into metal containers and cleaned.

Used rags and cloths should be stored outside, in self-closing metal receptacles.

Because paint-soiled clothing may ignite spontaneously, such clothing must be stored in metal lockers only. Paint-soiled clothing should be laundered as soon as possible.

Rubber gloves should always be worn when handling paints, cleaning compounds, paint and varnish removers, thinners, or other materials that may irritate the skin.

Care must be taken to avoid transfer of toxic (poisonous) ingredients to the mouth, as well as to prevent skin irritation. Do not eat foods exposed to toxic dusts or vapors. Clean your hands thoroughly before eating.

Do not use thinners to remove paint from the skin. Patches of paint which cannot be removed with a good hand soap and water may be loosened up with a little linseed oil.

Remove immediately to fresh air, anyone who is overcome by vapor or dust inhalation, and call for medical assistance at once. If the victim stops breathing, apply artificial respiration.

WINDOW GLASS AND GLAZING

The repair of wooden structures often involves the replacing of broken window glasses. Before painting, check for broken glasses and replace them. It is well to remember that the term GLAZING is used in referring to the process of setting glass in a sash or frame.

The puttied face of a wooden sash is placed outside. When a broken window is to be replaced in a wooden sash, start by removing all the broken glass and glaziers' points (or other holding devices). GLAZIERS' POINTS are flat triangular-shaped or diamond-shaped pieces of metal which are used to hold the glass in place in a wooden sash. All old putty must also be removed from the rabbet (groove) of the window sash. After cleaning the rabbet, it may be desirable that a coating of linseed oil or thin paint be applied. The purpose of this coating is to keep the fresh putty, which will be placed in the rabbet, from drying out too quickly.

A thin layer of fresh putty is placed in the rabbet of the sash, and a new glass then is pressed into the putty to an even seating. This operation is known as BEDDING. The next step is to drive in glaziers' points, spacing them about 6 to 8 inches apart. The remainder of the rabbet is then filled with putty and smoothed off with a putty knife. This is called FACE PUTTYING. BACK PUTTYING consists of forcing putty into any spaces which may be left between the edges of the rabbet and the glass.

On steel windows the putty surface is usually on the outside (as with wooden sash), but it may be on the inside. In the more expensive grades of metal sash, metal molds or strips are used instead of putty. The glass if preferably back-bedded and back-puttied.

Besides clear window glass there are other kinds used in building construction, such as polished plate, processed, rolled figured sheet, figured plate, wire, prism, corrugated, safety, and heat-absorbing.

Clear window glass is available in three qualities and six strength or weight classifications. A quality double-strength glass frequently is used. Polished plate glass is available in two grades and various thicknesses; glazing quality, 1/4 inch thick, often is suitable. Corrugated glass usually is 3/8 inch thick and contains wire reinforcement.

CHAPTER 8

CONCRETE AND MASONRY

This chapter will introduce you to the ingredients of concrete and to some of the properties which make it a desirable construction material. As a Constructionman striking for Builder, you will serve mostly as a helper in connection with concrete, typical duties being the hand mixing of concrete and mortar, handling and storing ingredients and other materials, hauling concrete in wheelbarrows or buggies, and general housekeeping tasks. A helper also works with various types of masonry units, such as brick, stone, structural clay tile, and concrete blocks. Information you need to know about masonry is included in this chapter. Greater detail on masonry is provided in the Builder training manuals.

CONCRETE AND MASONRY STRUCTURES

Concrete and masonry structures are among the most common projects of the SEABEES—especially in the development of overseas permanent naval bases. Because these structures are durable, strong, and adaptable to any type of architectural design, the SEABEES are very interested in their construction, and through research and testing much knowledge has been gained regarding the characteristics and behavior of concrete structures under stress and under exposure to the elements. These studies are mostly done by scientists at the Naval Civil Engineering Laboratory (NCEL), Port Hueneme, California. The data derived form these studies assist the Navy in utilizing concrete and masonry with greater ease in placement and the most economical way.

Load-bearing concrete (as, for example, concrete in beams and pillars in a building, or concrete in arches and girders in a bridge) is usually reinforced with steel embedded in the concrete. Reinforcing steel in slabs, as in a floor, usually consists of welded wire mesh. For beams and other concrete members which must stand heavier loads the reinforcing steel usually consists of steel bars called reinforcing bars—shortened to "rebars."

Brick is used mainly in dwelling-house construction and in the construction of relatively small industrial buildings such as garages and single-story shops or warehouses. However, larger buildings of two or more stories are still occasionally constructed of brick.

Concrete block has, to a large extent, supplanted brick for masonry structures, and many structures which are faced with brick have the brick facing backed by concrete block.

If you are assigned to one of the naval bases overseas, or have a chance to visit one of them, you will see beautiful concrete and masonry structures which were mostly built by the SEABEES during their deployment. These structures include both officers' and enlisted men's quarters, schools, exchanges, churches, barracks, office buildings, piers, bridges, and similar structures. Examples of structures built by SEABEES are shown in figures 8-1 and 8-2. Although the Builders are primarily responsible for constructing concrete structures, all SEABEE ratings are involved in various ways, and thereby contribute toward their completion.

CONCRETE MATERIALS

Concrete is a synthetic construction material made by mixing cement, fine aggregate (usually sand), coarse aggregate (usually gravel or crushed stone), and water together in proper proportions. The mixture is not concrete unless all four of these ingredients are present.

Most cement used today is portland cement, which is usually manufactured from fine-ground limestone mixed with shale, clay, or marl. Five common types of portland cement are discussed below.

Type I, "normal" portland cement, is a general-purpose portland cement used to make

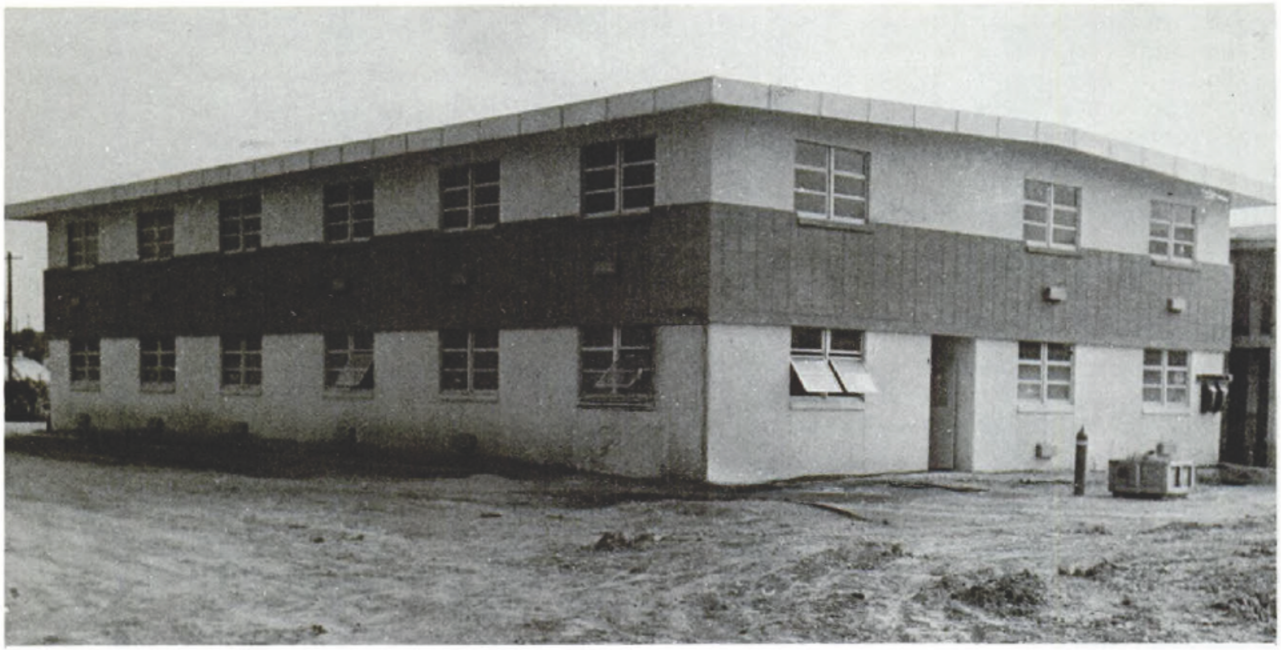

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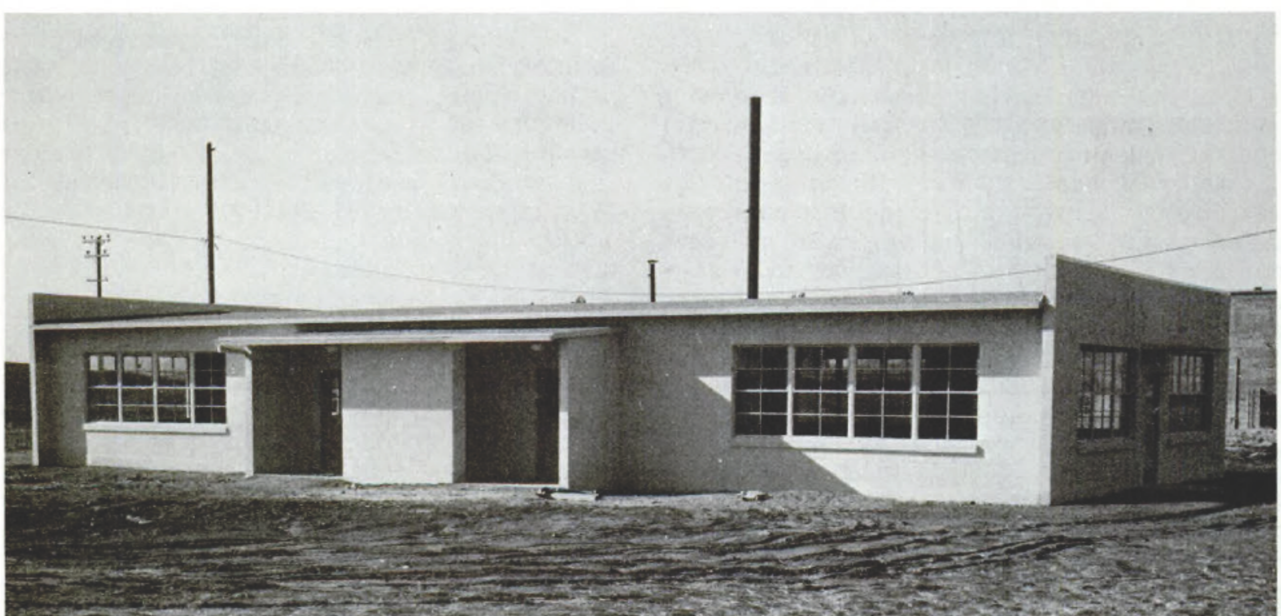
Figure 8-1.—Enlisted quarters built by SEABEES at Camp Shields, Okinawa.



29.417
Figure 8-2.—A SEABEE-built building using standard concrete blocks.

concrete for pavements, sidewalks, buildings, bridges, tank reservoirs, pipes, and concrete masonry units.

Type II, "modified" portland cement, has a lower heat of hydration then type I, which improves resistance to sulfate attack. It is intended for use in structures of considerable size where cement of moderate heat of hydration will tend to minimize temperature rise, as in large piers, heavy abutments, and heavy retaining walls and when the concrete is placed in warm weather. In cold weather when the heat generated is helpful, type I cement may be preferable for these uses. Type II cement is also intended for places where an added precaution against sulfate attact is important, as in drainage structures where the sulfate concentrations are higher than normal, but not usually severe.

Type III, "high-early-strength" portland cement, contains an accelerating ingredient which causes it to harden quicker than normal or type I. It is often desirable to speed up the hardening interval so that the concrete surface may be used as soon as possible.

Type IV, "low-heat" portland cement, is a special cement for use where the amount and rate of heat generated must be kept to a minimum. The developmen of strength is also at a slower rate. It is intended for use only in large masses of concrete such as large gravity dams where temperature rise resulting from the heat generated during hardening is a critical factor.

Type V, "sulfate-resistant" portland cement, is a cement intended for use only in structures exposed to high alkali content. It has a slower rate of hardening than normal portland cement. The sulfates react chemically with the hydrated lime and the hydrated calcium aluminate in the cement paste. This reaction results in considerable expansion and disruption of the paste. Cements which have a low content of calcium aluminate have a great resistance to sulfate attack. Thus, type V portland cement is used exclusively for situations involving severe sulfate concentrations.

For our purposes here, aggregate may be defined as the "inert" (non-active) ingredient which is combined with the active ingredients (cement and water) to make concrete. The aggregate is divided into "fine" and "coarse." Roughly speaking, you might say that anything coarser than sand is in the coarse category. For most ordinary building concrete, the maximum size of a coarse particle is about 2 1/2 inches (largest diameter). A massive structure like a dam, however, may use natural stones or rocks up to 6 inches or more in diameter.

The sand used in concrete should be clean and sharp, without any admixture of clay, loam, fine dust, or organic matter such as weeds or moss. These materials would prevent a good bond between the cement and the sand, and thus cause a loss of strength.

The water used in concrete must be clean and free from significant quantities of oil, acid, salt, alkali, silt, or organic matter. The hardening process in concrete is caused by a chemical reaction between the cement and the water, called "hydration" of the cement. The objectionable substances mentioned would interfere with hydration. In general, any water fit for drinking is suitable for making concrete.

MASONRY MATERIALS

The most commonly used masonry units are brick, concrete block, and structural clay tile. Bricks are made of clay or shale, burned to the desired hardness by baking in kilns at high temperature. Variations in the physical and chemical characteristics of the clay or shale, and variations in baking temperatures, account for the various colors and hardnesses found in the finished bricks.

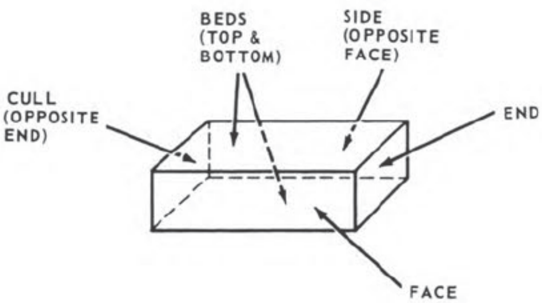
Besides the well-known red clay or shale brick, there are "sand-lime" bricks and "concrete" bricks. Sand-lime bricks are made of sand, lime, and crushed stone or crushed blast furnace slag. They are hardened by high-pressure steam. Concrete bricks are made of portland cement and sand, with a coarse aggregate which may be gravel, crushed stone, burned clay or shale, or slag, or a combination of all or several of these.

A standard-size U. S. brick measures 2 1/4 by 3 3/4 by 8 inches. The names of the surfaces are shown in figure 8-3.

The bricks in a brick wall are classified as "face" brick and "backup" brick. The face brick are those which show on the wall surface. They are often of better quality than the backup brick—these being the brick placed behind the face brick.

"Common" brick are brick made from pit-run clay, with no special effort made to control color, texture, or finish surface quality. Backup brick nearly always consists of common brick.

Concrete blocks are made in various shapes, some of which are shown in figure 8-4. They are often called cinder blocks, because these units were made in former times with cinder or slag



29.141
Figure 8-3.—Names of brick surfaces.

coarse aggregate. However, block is now made with ingredients similar to those used in any other concrete, except that the maximum size of coarse aggregate is about 5/8 inch.

Structural clay tiles are made by forcing clay through special dies, cutting to size, and baking as with brick. Construction tiles are shown in figures 8-5 and 8-6.

Masonry units are bound together with "mortar," a mixture of sand, cement, and water in proper portions. A certain amount of lime is usually added to increase the workability; in the trade, this is referred to as making the mortar "buttery." "Grout" is a mixture of cement and water ("neat-cement" grout) or a mixture of

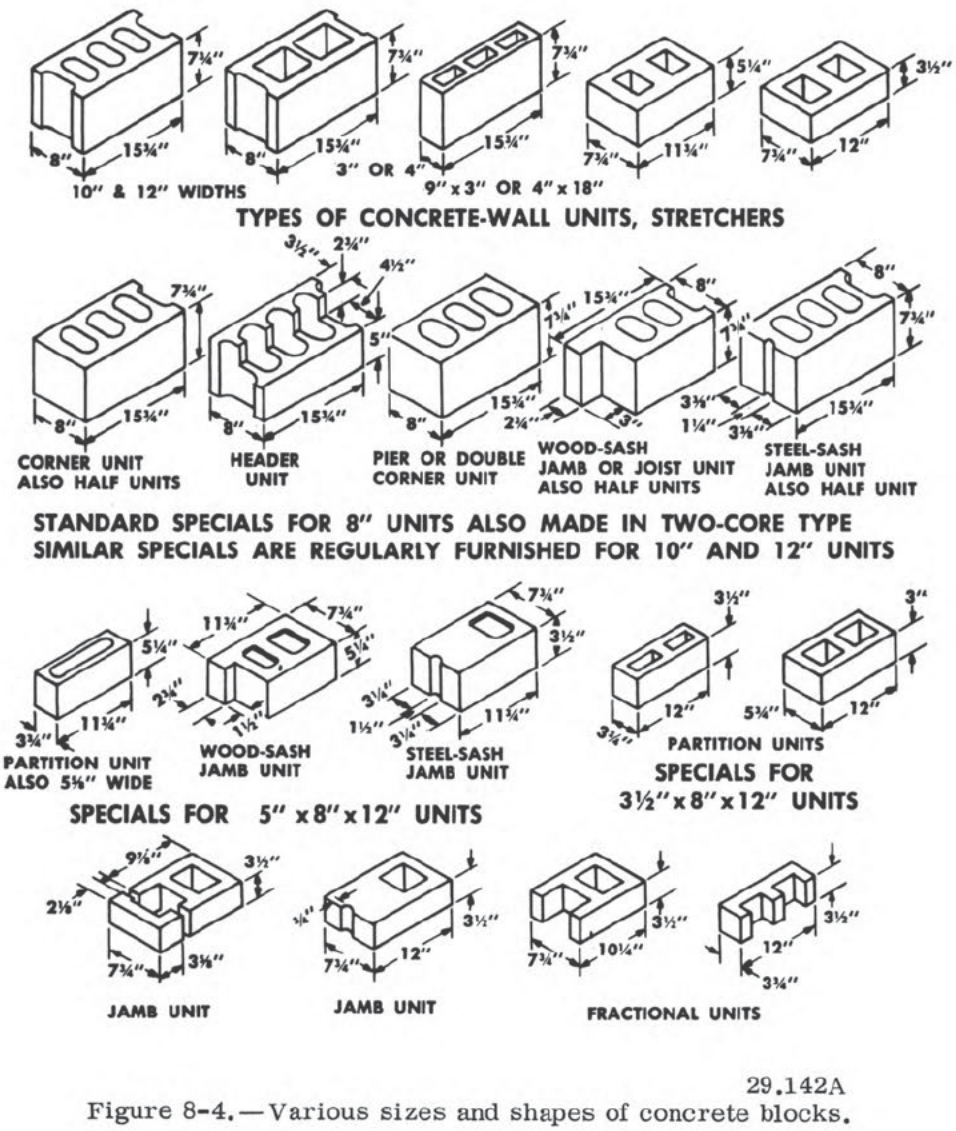


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Figure 8-4.—Various sizes and shapes of concrete blocks.

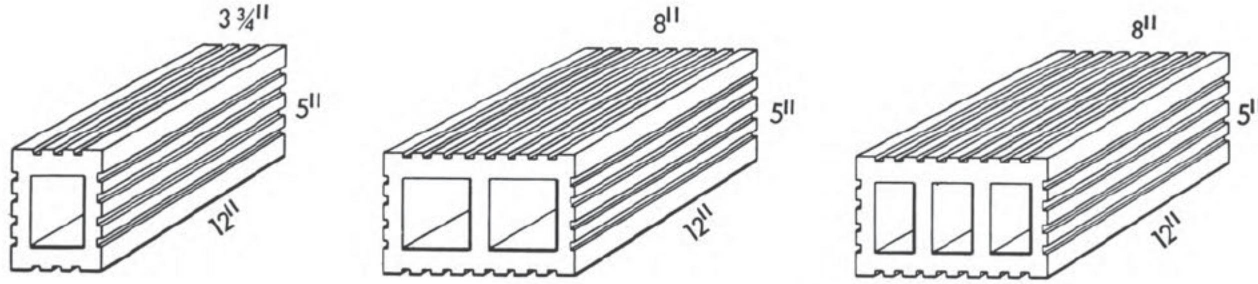

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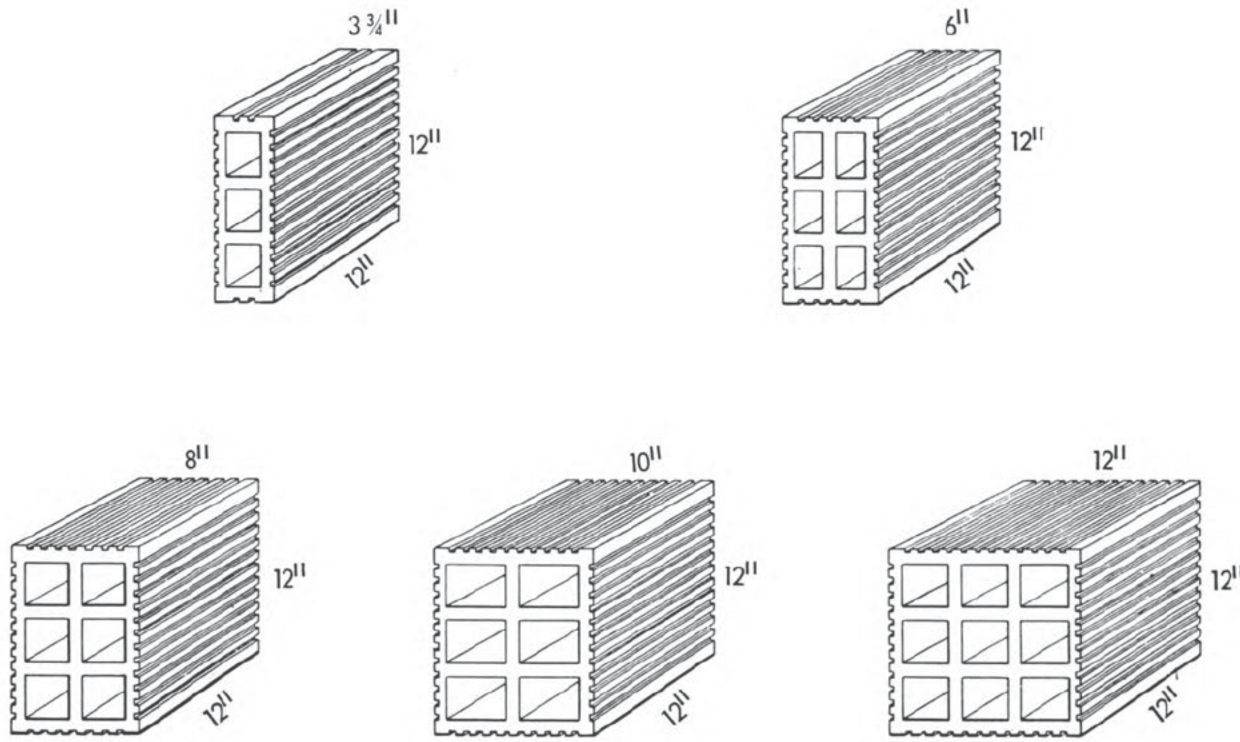
Figure 8-5.—Side-construction clay tiles.



29.144
Figure 8-6.—End-construction clay tiles.

sand, cement, and water (''sand-cement'' grout) used for filling cracks and for ''bedding'' machinery bases to concrete platforms, wooden sills to concrete foundation tops, and the like.

STORAGE OF MATERIALS

Portland cement in bulk is transported in ships, railroad cars, and bulk cement trucks, and loaded into bulk cement ''silos.''

Sacked portland cement comes in paper sacks, each containing 94 pounds of cement with a loose volume of 1 cubic foot. Warehouses or sheds for storing sacked cement must be as nearly watertight and airtight as possible. The floor of such a structure should be above ground to protect the bottom tiers against dampness. Sacks should be stacked close, to minimize air circulation between them. Do not stack them against

outside walls, because sacks so placed (especially against concrete or masonry walls) tend to absorb moisture from the walls. Sacks of cement must be stacked at least 8 inches from walls, ground or floor. Do not stack sacks of cement more than 10 sacks high. If sacks will be in storage for a long time, they should be covered with tarpaulins.

When inside storage is not available, sacks must be stored in the open, in which case they should be laid on raised platforms and covered with waterproof tarpaulins.

Sacks of cement that are kept in storage for a long time sometimes acquire a hardness called WAREHOUSE PACK. This is often extreme enough to make you think the cement must have become wet and hydrated; however, you can usually loosen up warehouse pack by rolling a sack around. Do not use cement until it has been made free-flowing and is without lumps.

Aggregates are often stored in bins in a batching plant, as explained later. If they are stored in piles, the piles are built up in horizontal layers, not in a cone shape made by dropping each load at the same spot. Cone-shaping a pile causes segregation of particles, because the larger particles tend to run down the sides of the cone. The first layer of a pile is completed before the second is started, the second layer before the third is started, and so on.

Concrete blocks or other masonry units should never be stacked on uneven or soft ground. If a hardened surface (such as an asphalt or concrete surface) is not available, planks should be laid.

FOUNDATIONS

The most important part of a structure is the FOUNDATION. In a building, for example, the foundation is that part of the building that bears directly on the ground; putting it another way, it is the foundation which supports the entire building from the ground up. The foundation is generally constructed below the ground surface so that it will have a foothold on the ground and prevent the movement of the structure it supports. How deep the foundation should be, depends upon the type, purpose, and importance of the structure, and upon other engineering requirements. Foundations may consist of footings, concrete slab, piles, piers, or solid rocks.

As a Constructionman, you may assist the Builders in excavating the site for these foundations. Follow strictly the safety precautions described earlier in chapter 6 of this training manual.

FORMS FOR CONCRETE WORK

Most structural concrete is "monolithic" (that is, "one-piece" rather than made up of separate units as with masonry) concrete which is made by pouring mixed "plastic" concrete into the spaces enclosed by previously constructed "forms." The forms hold the concrete in place (fig. 8-7) until the curing (hardening) interval has passed, after which the forms are usually "stripped."

For highway pavement, steel "side" forms are commonly used. Besides serving as side forms for the cast concrete, these forms are equipped with track flanges for the wheels of mechanical paving equipment.

Most monolithic concrete other than in highway pavement is cast in wooden forms. The part of the wooden formwork which actually contacts the concrete is called the "sheathing." The remainder of the formwork, called falsework, consists principally of wooden members which support the sheathing. Most sheathing nowadays consists of plywood panels. Supporting lumber is usually pine, fir, or spruce dimension lumber. A concrete form using plywood sheathing and dimension lumber is shown in figure 8-8.

It is essential that forms for concrete work be tight, strong, and rigid. If forms are not tight there will probably be leakage of water or of cement paste, causing "sand streaking" and loss of strength due to incomplete hydration. To keep forms in rigid alignment, they must be properly braced and supported with studs and other framing and bracing members placed at sufficiently close intervals. If forms are to be stripped after the concrete hardens, they are oiled with a suitable form oil before the concrete is placed. The oil prevents the formwork from adhering to the concrete.

As a Constructionman, you may serve as a helper in carrying form materials, oiling forms, doing housekeeping tasks, and so on. You may also assist in stripping. Stripping formwork is discussed later in this chapter.

Make sure before oiling formwork that the surfaces of wooden forms are smooth and the surfaces of steel forms free from irregularities. Oil should be applied evenly with a brush or swab. Any excess should be wiped off.

29.418
Figure 8-7.—Placing concrete in forms.

BATCHING AND MIXING CONCRETE

The steps in a given concrete job, after the forms are erected, consist usually of the following, in the order given:

1. Batching—meaning the measuring out or weighing out of ingredients (coarse aggregate, fine aggregate, cement, and water) in prescribed proportions.

2. Mixing—consisting first of thoroughly mixing the "dry" ingredients together (the coarse aggregate, fine aggregate, and cement), and second of mixing the same with the proper amount of water added.

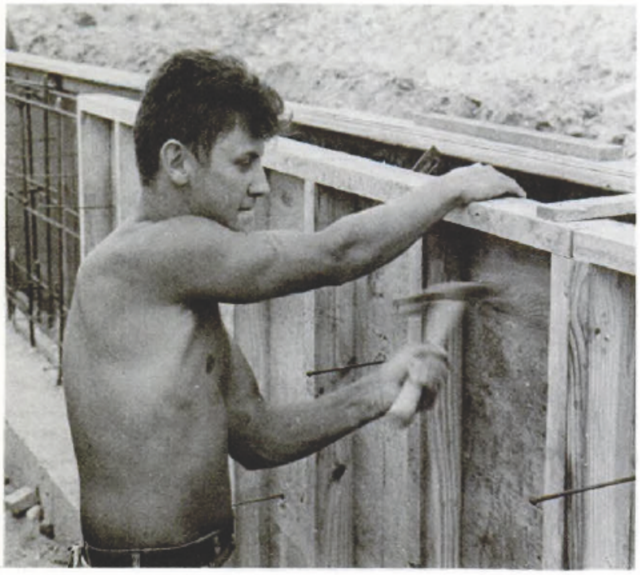
3. Transporting—meaning the carrying of the mixed concrete to the place where it will be poured into the forms.

4. Placing—meaning the pouring of the mixed (still plastic) concrete into the forms, and the consolidation of the same.

5. Finishing—meaning the surface smoothing, if and as required.

6. Curing—meaning not only the allowance of a proper time interval for hardening, but also the taking of certain precautions, described later, to prevent loss of strength during this interval.

The prescribed ingredient proportions for concrete are given in a field-mix formula which might be something like 1:2:3 by volume, or 1:2:3 by weight. If the proportions are by volume, the formula 1:2:3 means 2 cubic feet of sand and 3 cubic feet of coarse aggregate to every 1 cubic foot of cement (a sack of cement has 1 cubic foot of loose volume). If the proportions are by weight, the formula 1:2:3 means 2 weight



29.419

Figure 8-8.—Concrete forms using plywood sheathing and dimension lumber.

units of fine aggregate and 3 weight units of coarse aggregate to every 1 weight unit of cement. If sacked cement is being used, a sack weighs 94 pounds. Therefore, for every sack of cement there would be 2 x 94, or 188 pounds of fine aggregate, and 3 x 94, or 282 pounds of coarse aggregate.

You can see that, whether proportions are by weight or by volume, the field-mix formula refers to a one-sack batch. Usually the quantity mixed at a time will exceed this amount. A common type of machine mixer, for example, can handle 16 cubic feet of mixed concrete. A one-sack batch produces about 4.5 cubic feet of mixed concrete. A 16 cubic-feet mixer, then, would accommodate at least a three-sack batch. If the field-mix formula was 1:2:3 by weight, you would feed into the mixer 3 x 188, or 564 pounds of sand; 3 x 282, or 840 pounds of coarse aggregate; and 3 sacks of cement.

How much water would you add to this? Well, the water-cement ratio is of vital importance in concrete, because it is this ratio which is the chief factor in determining strength. The ratio is specified in the terms of number of gallons of water to each sack of cement used, the number of gallons being commonly somewhere between 5 and 7.

Batch-Plant Batching

The large quantities of aggregate required on a large concrete job are weighed out in an aggregate batching plant like the one shown in figure 8-9. Here the fine and coarse aggregate are loaded by a clamshell crane into large bins. Below each bin there is a weighing platform, which regulates the flow of aggregate by opening a discharge gate. The aggregate can then be chuted into a truck standing below for transport to a mixer, or chuted into a transit-mixer.

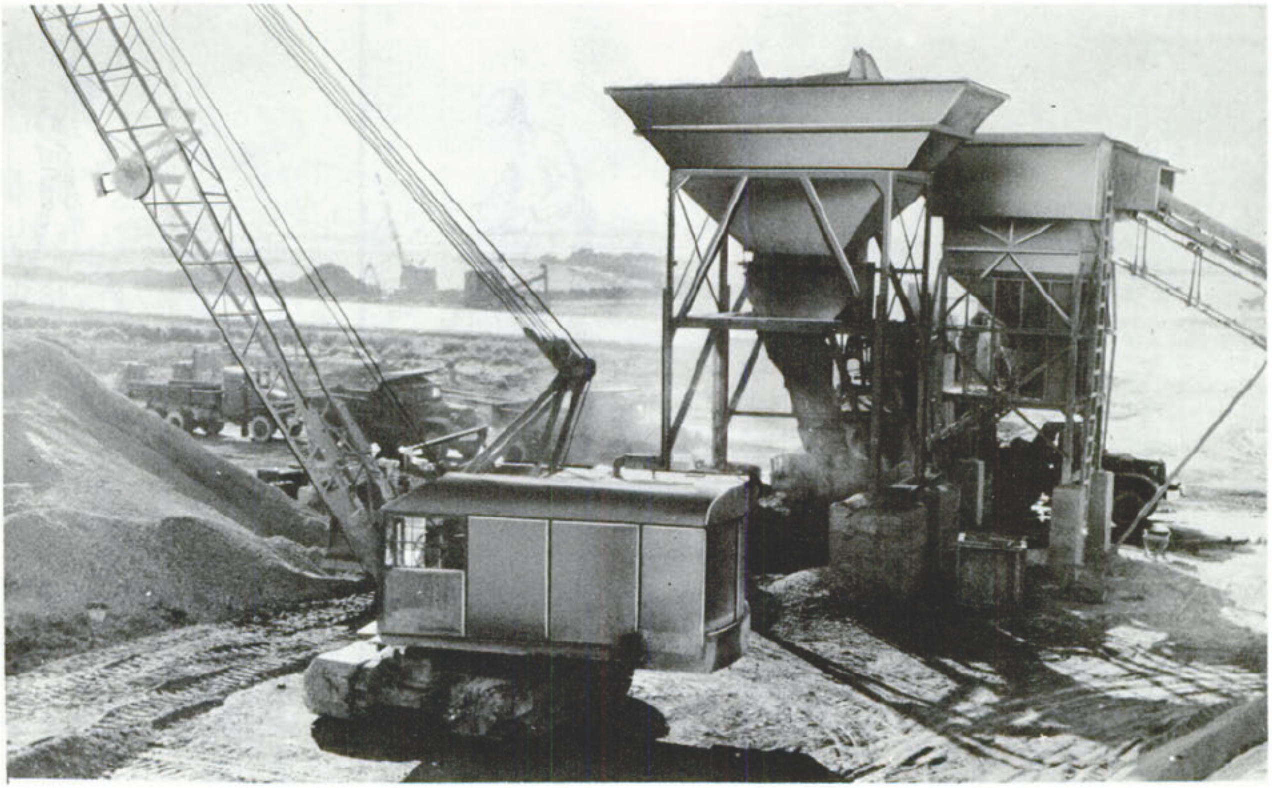
Machine Mixing

There are various types of machines for mixing concrete. Figure 8-10 shows a model 16-S (skip) mixer; the figure 16 indicates that this machine has a rated capacity of 16 cubic feet of mixed concrete. You pour into the skip the coarse aggregate, fine aggregate, and cement required for a 16 cubic-foot batch. When you work a lever, the skip rises to dump the dry ingredients into the drum.

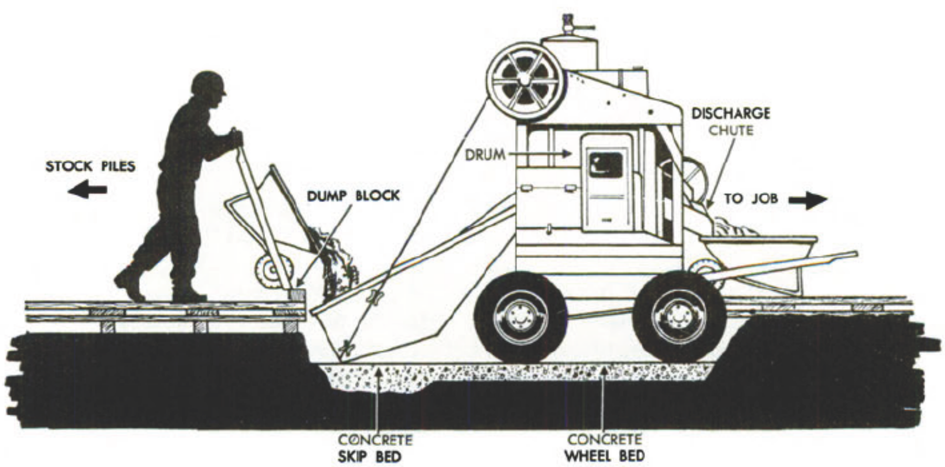
Previously you set a controller on the water tank for the amount of water required for a 16 cubic-foot batch. You start the water into the drum just before the skip dumps, and let the drum rotate to mix the concrete for about a minute and a half. You then work a discharge lever to discharge the mixed concrete into a wheelbarrow or other container.

Figure 8-11 shows a model 34-E PAVER. A paver is simply a crawler-mounted concrete mixer equipped with a boom-and-bucket rig (not shown in fig. 8-11) for running out the concrete and dumping it at a distance from the mixer. A succession of dump trucks, loaded with dry ingredients at a batch plant, backs up to the paver skip to supply the mixer with dry ingredients. Again the water is supplied from a tank on the paver.

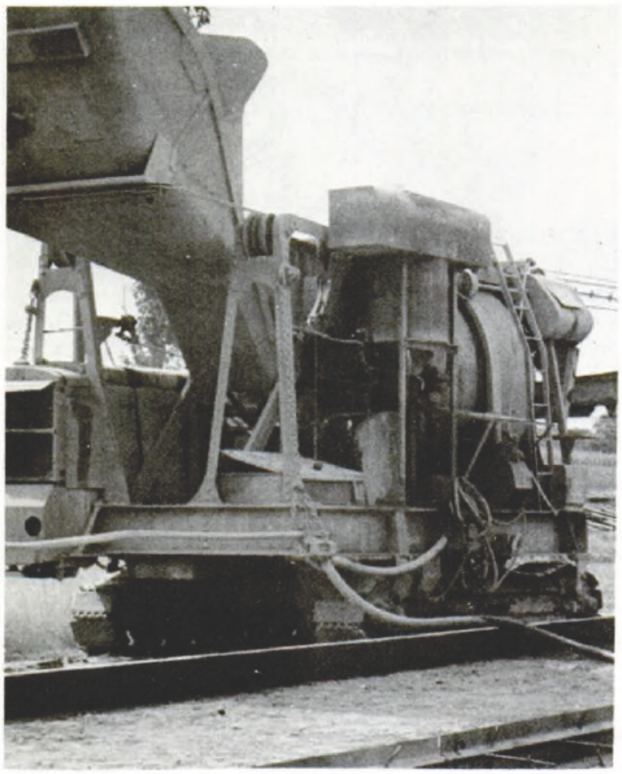
A transit mixer is a concrete mixer (complete with water tank) mounted on a truck. The truck first picks up a supply of aggregate at an aggregate batching plant; then proceeds to a cement silo and takes on the corresponding quantity of cement. The truck then proceeds to the jobsite, wherever that may be. At a predetermined time before arrival at the jobsite, the driver runs in the preset amount of water from the tank (he has agitated the dry ingredients on the way by allowing the drum to rotate slowly) and rotates the drum, allowing a minute or two per yard of concrete, to obtain the wet-mix. He then chutes the concrete where directed.



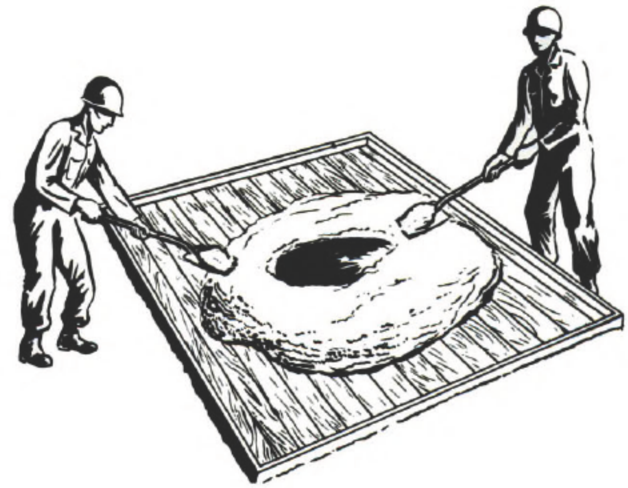
29.153
Figure 8-9.—Concrete aggregate batching operation.



29.151
Figure 8-10.—Charging a 16-S mixer.



29.152
Figure 8-11.— Model 34-E paver.



29.154
Figure 8-12.— Platform for hand mixing of concrete.

Hand Mixing

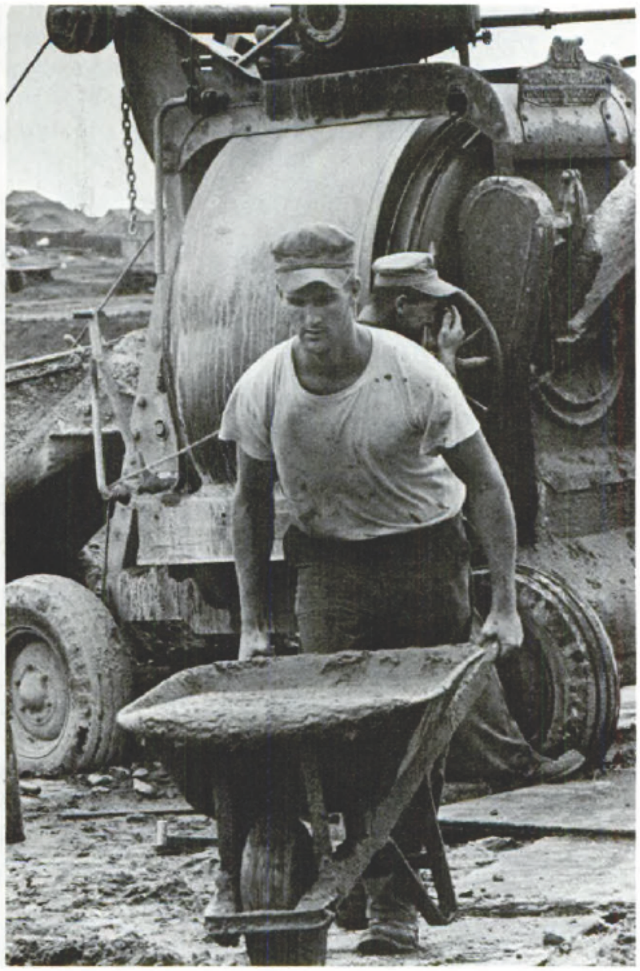
For hand mixing, you need either a metal mortar box, metal-lined wooden mortar box, or simply a watertight wooden mortar box similar to that shown in figure 8-12. The first two, however, are more preferable. Suppose you are going to mix a series of batches, each consisting of 2 sacks of cement, 5.5 cubic feet of sand, 6.4 cubic feet of coarse aggregate, and 12 gallons of water. You will need a shovel (two if there are two men mixing), a volumetric measuring box (a one-cubic-foot box equipped with stretcher-type handles for carrying by two men, marked off inside in tenths of a cubic foot), and a bucket marked off inside in gallons, half-gallons, and quarter-gallons.

First mix the dry ingredients as follows: Dump 3 cubic feet of sand on the platform and spread it out in a layer. Dump one of the two cement sacks on top of the sand layer, dump the remaining 2.5 cubic feet of sand over the cement, and the second sack of cement on top of this sand. Now mix the sand and cement thoroughly together by working from the outside of the pile inward and turning the material as many times as is necessary to give it a uniform color throughout.

When the cement and sand have been thoroughly mixed, level off the pile, add the coarse aggregate, and mix it in thoroughly by as many turnings as are required. Then trough the pile in the center, fill the trough with mix water, and mix the water in by turning the dry ingredients into it. Repeat the process of troughing the pile, filling the trough with water, and turning the dry ingredients into the water, until all the mix water has been added. Then mix the batch to a uniform consistency throughout, a procedure which usually requires a minimum of at least four more complete turnings.

TRANSPORTING AND PLACING CONCRETE

Concrete may be chuted directly from a mixer (such as the one on a transit-mix truck) into the forms as shown in figure 8-7. Hand-mixed concrete, however, must usually be transported from mixing platform to form by wheelbarrow (fig. 8-13), or by another type of wheeled, hand-pushed conveyor called a BUGGY. Sometimes a machine mixer chute cannot be extended far enough to reach all parts of the formwork, in which case the mix must be chuted into wheelbarrows or



29.420
Figure 8-13.—Using a wheelbarrow to transport concrete mix.

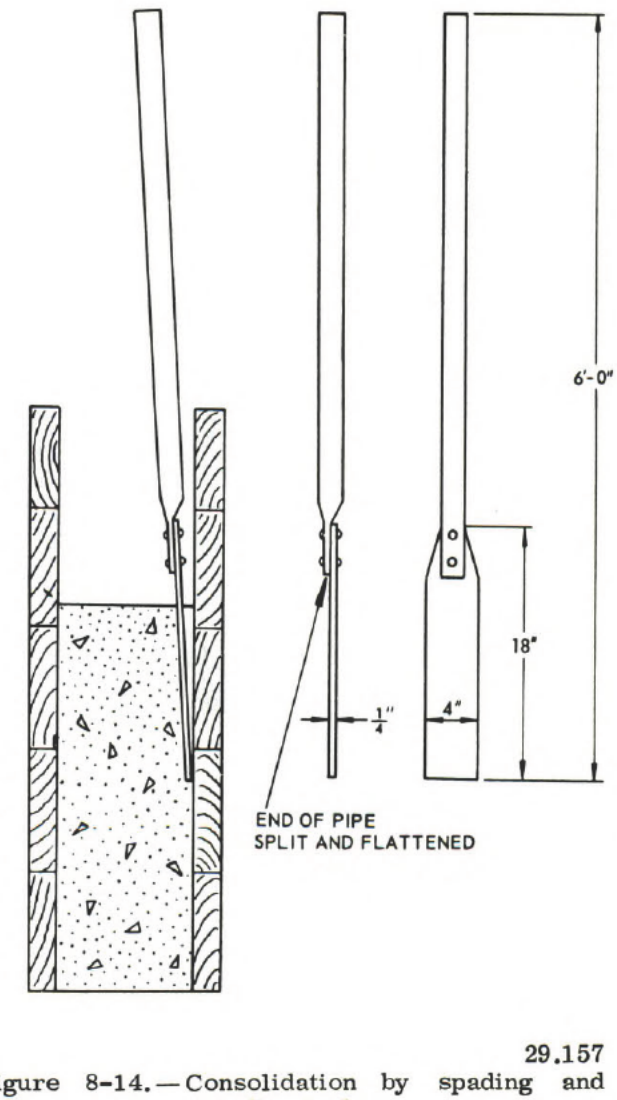
buggies for transportation to the point of placement.

When concrete is being placed by dumping from wheelbarrows or buggies, each load should be dumped as nearly as possible in the position it will finally occupy. In a slab form, for example, loads should not be dumped in the center and then spread out by shoveling, but should be dumped successively adjacent to each other. The more concrete is shoveled or otherwise handled, the more it tends to segregate.

On large projects, a crane and bucket, a portable concrete pump, or a conveyor belt with vibrator is used to transport concrete to the point of placement. These methods are more efficient and require less personnel for placement.

A part of the placement procedure consists of consolidating the concrete. Consolidation helps to settle and level the concrete, to eliminate trapped air bubbles, and in the case of finish surfaces formed by the sheathing (as in a wall form), to bring fines to the surface to cover the coarse aggregate and create a smooth finish.

Consolidation in relatively narrow form spaces may be done by spading as shown in figure 8-14. The spading tool is shoved down along the inner surface of the sheathing, through the layer to be spaded and several inches into the



29.157
Figure 8-14.—Consolidation by spading and spading tool.

layer previously placed. The handle is then levered back and forth several times. Figure 8-14 shows one type of spading tool. Another satisfactory type can be made by bending the blade out straight on an ordinary garden hoe.

For larger form spaces consolidation is done with an internal vibrator like the one shown in figure 8-15. There are also external vibrators, which are placed against the outside sheathing surfaces to create a smooth finish.

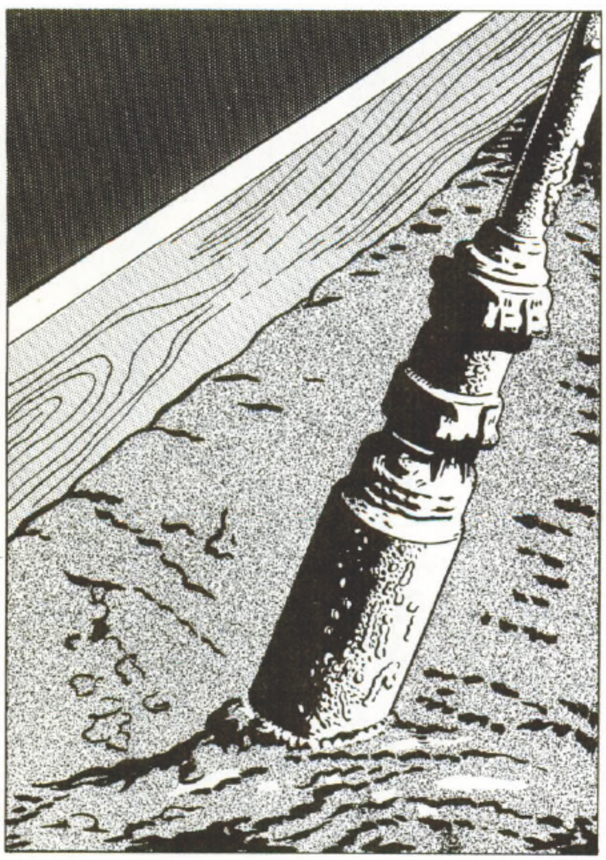
FINISHING CONCRETE

The term "finishing" applies to all concrete work; it means the smoothing or dressing of concrete to obtain an attractive or functional surface. For slab work, such as floors, the concrete is "struck off" level with the side forms and then smoothed down. In highway or sidewalk work, where for safety the surface must be rough, the concrete is struck off and then a light broom is run over it. The surfaces of a concrete wall are finished by spading and/or the vibrating process. After the forms are stripped the walls are smoothed by applying coatings and/or rubbing or tooling.

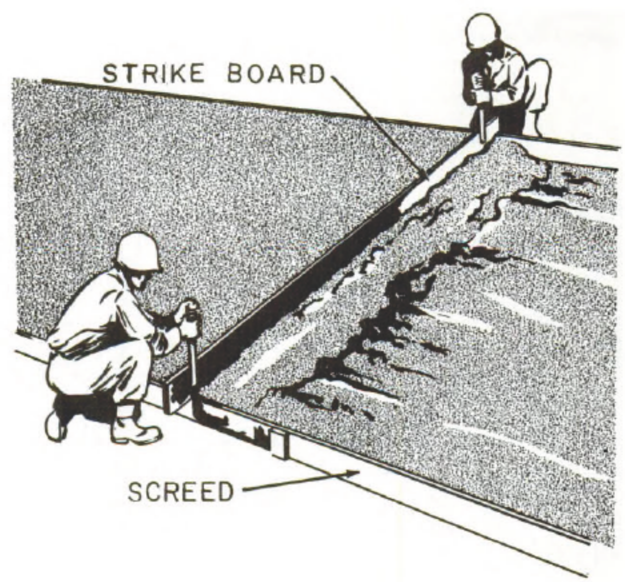
For a slab the finishing process usually consists of screeding, floating, and troweling, in that order. Screeding, the process by which the concrete is struck off level, is illustrated in figure 8-16. Two men work the strike board along with a sawing motion, as shown.

Shortly after screeding the surface is floated as shown in figure 8-17, or a long-handled float, called a bull float, may be used as shown in figure 8-18. A float is a smooth-faced slab or strip of wood which, as it is passed over the concrete surface, raises fines to cover the coarse aggregate with a smooth surface finish. Floating must not be overdone, because too much of it will raise an excess amount of fine aggregate to the surface. This will cause the surface to be weak and easily abraded.

When a dense, smooth finish is desired, floating is followed by troweling with a steel trowel like the one shown in figure 8-19. Troweling is not begun until the surface has hardened enough to prevent fines from being brought up by the trowel. It must not be delayed, however,



29.158
Figure 8-15.—Internal vibrator.



29.160
Figure 8-16.—Screeding.

to the point where the surface is too hard to be affected by the trowel.

Troweling should leave the surface smooth, even, and free of marks and ripples. A fine-textured surface may be obtained by following a first regular troweling immediately with a second troweling in which the trowel, held flat, is passed lightly with a circular motion.

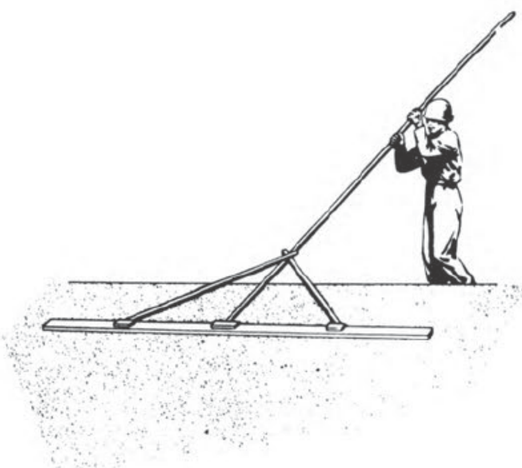
If a hard steel-troweled finish is desired, the second troweling should be delayed until the concrete has hardened enough to emit a ringing sound under the trowel. In hard steel-troweling the trowel is tilted slighted and pressed hard to compact the surface. Experience will enable you to tell just when the surface is ready for final finishing.

29.162
Figure 8-17.—Floating.

CURING CONCRETE

The hardening process in concrete is a chemical reaction between the water and the cement. It is not a drying out process—concrete will harden under water as well as it will in the air.

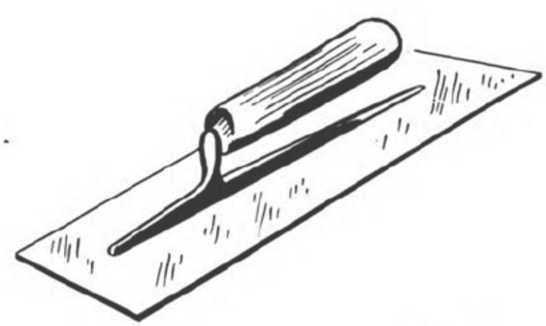
In point of fact, it is essential that concrete be prevented from drying out during the hardening interval. Concrete takes an initial "set" in about 1 1/2 hours; a final set takes about 10 hours, except in the case of high early-strength concrete.



29.163
Figure 8-18.—Long-handled wood float.

The process of curing is designed to prevent surface evaporation of water in the mix during the hardening interval. If surface water evaporated, the surface water supply would be insufficient for the complete hydration of the cement.

There are various methods of curing. One which is commonly used is to cover a slab surface with canvas, burlap, cotton mats, straw, plastic sheeting, or some similar material, and to keep the material moist by sprinkling during the hardening interval. Wall surfaces may be kept moist by wet burlap sacks or other absorbent materials. Concrete slab may be cured by ponding. In ponding a low dike of earth is built around the area to be cured, and the area inside the dike is kept flooded.



29.164
Figure 8-19.—Steel trowel.

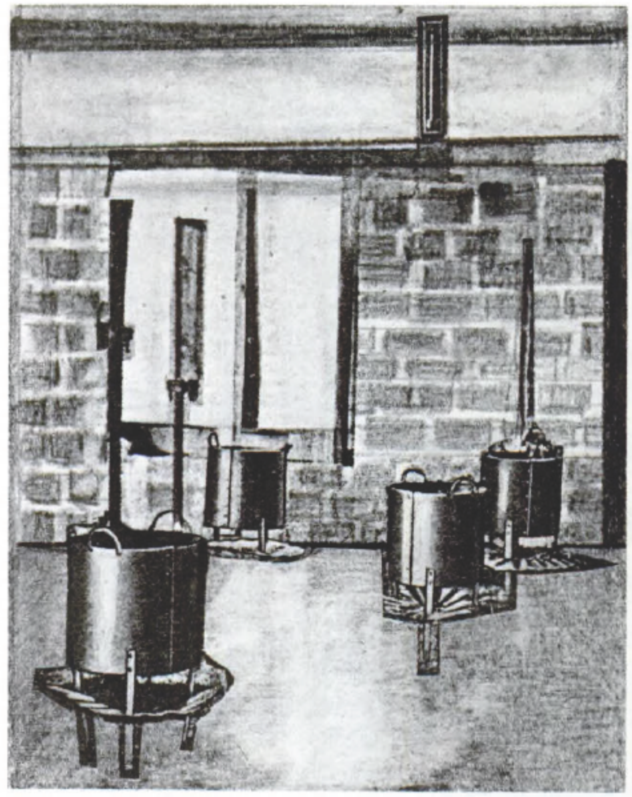
Finally there is the method of curing slabs by spraying on a paraffin or other type of "membrane," which hardens to form a thin vapor-tight barrier and thus prevents evaporation of surface moisture.

CONCRETE IN EXTREME TEMPERATURES

In excessively hot weather the temperature of curing concrete must not be allowed to rise above 90°F. If cover-curing is being done, care must be taken that the cover is kept well moistened. Ponding is probably the best type of curing in extremely hot weather.

In below-freezing weather the temperature of the curing concrete should not be allowed to drop below 50°F for the first 72 hours. If the water in curing concrete freezes, the concrete will be permanently damaged.

Covering with canvas, straw, or similar material may provide sufficient protection. In very cold weather, however, it may be necessary to erect an enclosure, as with tarpaulins mounted on stakes, and heat the interior with steam, or with portable heaters, such as salamanders (fig. 8-20). In recent years, gasoline-, fuel oil-, or kerosene-fired heaters with electric blower fans have been added to the Toolroom Allowance. When portable heaters are used, ventilation must be provided to prevent the accumulation of carbon monoxide.



29.167
Figure 8-20.—Use of salamanders to heat an enclosure.

STRIPPING FORMS

The length of the interval after which formwork may be removed (called stripping) from concrete varies from 1 day to 14 days in accordance with various circumstances. Stripped lumber should be removed to a separate pile immediately. It should be cleaned and all nails should be removed before stacking. Stripping, cleaning, and stacking personnel should wear heavy gloves and safety shoes.

THE CN AS A MASON HELPER

As a mason helper the CN functions principally as materials handler and supplier. He keeps masons who are laying masonry units (brick, concrete block, and tiles) constantly supplied with units and with mortar. He also places and holds ends of alignment cords as directed, and for this duty must be close enough to hear a hail from the mason.

For hand mixing of concrete the CN supplies the materials, in amounts specified by the man in charge, and does the shovel mixing. Similarly, he combines and mixes mortar materials by direction. If there is a power mortar mixer, he feeds and operates it. He may operate a concrete mixer as well.

SAFETY IN CONCRETE AND MASONRY CONSTRUCTION

Concrete and masonry work involves handling heavy materials, and often carrying them up ladders and along scaffolding high in the air. Surveys seem to indicate that the major portion of the accidents which occur during construction operations happen in the course of materials handling.

PERSONAL PROTECTION

All personnel engaged in materials handling operations must wear approved safety shoes. Wearing sandals, open-toe shoes or thin-soled shoes is prohibited. Foot guards and leg guards

must be worn when the nature of the material being handled indicates a necessity for such protection.

Gloves must be worn by men engaged in carrying, lifting, or moving objects which are sharp, spiky, splintery, or otherwise hazardous to the bare hands (stripped formwork members and heavy masonry units like concrete blocks are thus hazardous).

Finger rings must not be worn by men engaged in materials handling.

HANDLING MATERIALS BY HAND

Personnel with existing hernias or with histories of repeated back-strain should report these facts to their superiors.

All personnel engaged in hand-handling should know the proper method of lifting a heavy object. This method may be roughly defined as "lifting with the legs and not with the back." The lifter should take position close to the object, with feet solidly placed and slightly apart. He should then lower himself to grasping position by SQUATTING, not by STOOPING OVER. After grasping the object firmly, he should raise both himself and it by STRAIGHTENING HIS LEGS, not by LIFTING WITH HIS BACK. During the whole procedure the back should be kept as nearly vertical as possible.

WHEELBARROW/BUGGY PRECAUTIONS

A wheelbarrow or buggy must never be so heavily loaded as to create a danger that it may "take charge" on a ramp or other incline. When ascending or descending an incline, the loaded barrow or buggy should be BELOW the man who is handling it, so that if it should happen to "take charge" it will not run over him. This means that a loaded barrow or buggy should always be PULLED UP an incline.

A wheelbarrow or buggy with a loose, cracked, or broken handle, or one with a twisted or out-of-round wheel, must be removed from service at once, and not used again until repaired.

Gloves or knuckle-guards must be worn by men who are steering wheelbarrows through narrow passageways.

A wheelbarrow should be loaded so as to place the center of gravity as far forward (toward the wheel) as possible. Obviously the purpose of this is to place as much of the load as possible on the wheel rather than on the handles. Handles should be lifted like any other load—that is, by the use of the leg muscles rather than the back muscles.

Except when ascending an incline, a wheelbarrow or buggy should be pushed, not pulled.

SCAFFOLD SAFETY

The following scaffolding safety precautions must be observed by all men working on scaffolds, or tending other men who are working on scaffolds.

1. Access to scaffolds must be by standard stairs or properly placed ladders ONLY.
2. When scaffolding is being dismantled, all nails should be drawn from members as soon as the member is detached.
3. Unstable objects, such as barrels, boxes, loose brick, building blocks, and the like, must not be used to support scaffold planking.
4. No scaffold may be used for the storage of materials in excess of those currently required for the job. A scaffold is designed to support only a certain maximum load per square foot.
5. Tools not in immediate use on a scaffold must be stowed in containers, to prevent tools left adrift from falling on persons below. Tool containers must be lashed or otherwise secured to scaffolds.
6. A scaffold must be kept clear of accumulations of tools, equipment, materials, and rubbish. This housekeeping duty is a responsibility of the CN mason's helper.
7. Throwing or dropping objects from scaffolds is ABSOLUTELY FORBIDDEN. Objects which cannot be safely carried up or down must be raised or lowered on hand-lines.

STORING AND HANDLING SAFETY

All material in bags, containers, or bundles, and any other material which is stored in tiers (layers) must be stacked, blocked, interlocked, and limited in height, so as to produce a stable pile which will not topple, slide, or collapse, especially when material is being removed. Material stored inside a building must not be placed within 6 feet of any hoistway or other floor opening. When outside walls are not yet constructed, material piled on an aboveground floor must not be piled within 10 feet of the outer floor edge.

Whenever possible, piling materials in a thoroughfare or walkway should be avoided. If materials must be so piled, piles should be located where they will present the least possible hazard and obstruction to traffic. Vehicle traffic must be warned by barricades and red flags by day and suitable lighting by night.

Cement and Lime Safety

Safety precautions for piling cement and lime are as follows:

1. Cement and lime are skin and eye irritants. Men handling these materials must wear goggles, and their clothing must fit tightly at neck and wrists. Men who are allergic to cement and lime should report the fact to their superiors. Men with sensitive skins should take extra precautions, such as frequent changing of clothing and the use of some suitable type of skin ointment.

2. Except when stored in bins, enclosures, or other structures which support the pile, bags of cement or lime should not be piled more than 10 bags high.

3. Outside bags in a pile should be placed with mouths inward.

4. Bags should be CROSS-PILED, meaning that bags in an upper layer should be laid at right angles to bags in the layer below it. At every sixth layer the pile should be set back one bag length.

5. For want of a better term, the reverse of piling is called UNPILING. Cement or lime should be unpiled in such as manner as to preserve the one-bag-length setback at every sixth layer.

Masonry Unit Safety

1. Masonry units may be piled directly on a paved surface, but never directly on a natural earth surface. On a surface of this kind, the bottom tier should be laid on a layer of planks.

2. No more than the amount of units required for current mason's operations may be piled on scaffolds or runways.

3. The maximum height for open, unsupported piles of brick is 7 feet. A pile should be set back 1 inch at the 4-foot level, and 1 inch at every foot thereafter. This taper must be maintained during unpiling.

4. Piles of concrete block should be limited in height to 6 feet whenever possible. If higher piles are unavoidable (because of limitations of space), each layer above 6 feet should be set back about half a block in length and width to stagger the joints; successive layers above 6 feet should be separated by wood-cross-stripping; and the pile should be securely braced and shored.

Loose Earth and Aggregate Safety

Burial alive in earth, sand, gravel, or similar loose material is one of the most frequent and terrible of construction accidents. The following precautions are aimed principally at preventing this type of disaster.

1. When earth, sand, gravel, crushed stone, or similar loose material is being removed from a more-than-man-high mass, the greatest care must be taken against the development of an overhang which might collapse and bury men beneath it. If the development of an overhang is unavoidable, it must be progressively shored up.

2. A man working on top of a mass of loose material in a hopper (such as a mass of sand or coarse aggregate in a batch-plant hopper) must be equipped with a safety belt and lifeline, and the lifeline must always be secured to the top of the hopper so that it at no time contains more than 2 feet of slack.

CHAPTER 9

STEELWORKING

In this age of space exploration, moon landings, nuclear powered ships, and sophisticated weaponry, the old Navy proverb of "Wooden ships and iron men" still holds some truth. True, the days of wooden ships have largely faded into the past, but the "Ironmen" of the Navy still play an increasingly important role—especially in the SEABEES. They are known as Steelworkers and their main occupational field is STEELWORKING.

Steelworking operations include metal working and fabrication, welding, steel placement and erection, and jobs involving hoisting equipment, tackle, and rigging. As a CN, you may be called upon to assist Steelworkers in carrying out these operations.

This chapter provides basic information on various phases of the Steelworker's job. You will notice that special attention is given to the subject of materials, the reason being that materials handling is again, as with concrete and wood construction, the principal function of the CN.

Some of the various types of steel structures erected by Steelworkers will be explained—such as buildings, towers, and tanks. Other topics discussed will include concrete reinforcing steel, rigging, welding and cutting, and metal shop work. Throughout the discussion the CN's duties will be specified, and relevant safety precautions will be set forth.

STEELWORKING MATERIALS

Steel is the Steelworker's principal material, but he also works with other metals, and with alloys (an alloy is a mixture of two or more metals). The Steelworker likewise works with various non-metallic materials—such as, the lines and tackles used to hoist heavy metal members.

This section contains basic information on a number of important types of materials used in steelwork, and provides pointers on the handling and care of specific items. In steelwork or any other trade the helpers as well as the journeymen should have a basic acquaintance with the materials used in the trade. An understanding of the uses of common materials will not only help you in the performance of actual duties, but also make the work more interesting and meaningful.

STEEL

Steel is a "ferrous" metal—meaning that is is made from iron ore. Iron ore is converted into "pig iron" in a blast furnace. Pig iron contains a high carbon content, and certain impurities as well. By one of several processes for converting pig iron into steel, the carbon content is reduced and most of the impurities are eliminated. Also, a certain amount of manganese, up to 0.80%, is added to combine with the sulfur or phosphorus in the steel to offset embrittlement and "hot shortness."

Steel used in construction is called structural steel. The most important types of STRUCTURAL steels are mild steel, medium steel, high tensile steel, high carbon steel, special-treated steel, and stainless steel. Plain carbon steels are alloys of iron and carbon, in which the quantity of carbon determines the properties of the steel—such as hardness and ability to respond to heat treatment.

Alloy steels have elements other than carbon added, the purpose being to develop certain desired properties. Among the more common alloying elements are nickel, chromium, vanadium, silicon, and tungsten.

STRUCTURAL STEEL

Steel intended for structural use is manufactured in a variety of shapes and sizes. These may be broadly classified as BARS and PLATES (flat steel), ROLLED STEEL SHAPES, STEEL PIPE, and STRUCTURAL TUBING. Structural steel is described in terms of its classification,

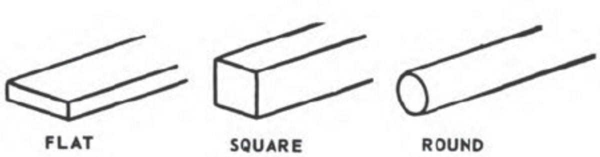
shape, dimensions, and weight per foot. The weight of structural steel is approximately 490 lbs. per cubic foot. An important thing to remember when discussing steel products in terms of classification and size is the fact that there are always exceptions. This book can only give those terms which are accepted as more or less standard.

Bars and Plates

Flat steel, in the thicknesses adapted for structural use, is generally classified as either bar or plate, depending on its width and thickness. BAR STEEL is 8 in. or less in width and it has a nominal thickness of 3/16 in. or more. The actual thickness is just a little thicker (.203 in. minimum). Bars are also produced with square, round, hexagonal, and octagonal cross sections. Three different types are illustrated in figure 9-1. Bar dimensions are expressed in width in inches, thickness in inches, and length in feet (W'' x T'' x L'), in that order. Square bar is designated by the width of one side, round bar by the diameter, and hexagonal or octagonal bar by the distance between the flat surfaces. Bars are most generally used for bracing other members in a structure. Smaller bars, other than flat bars, used for connecting or tying other members together, usually with threaded ends, are commonly referred to as RODS.

STEEL PLATE is flat steel over 8 in. in width with a nominal thickness of 1/4 in. or more except when the width is 48 in. or greater; in which case, the nominal thickness may be as little as 3/16 in.

Steel plates are frequently referred to by their width and thickness in inches and their length in feet and inches. You may also hear plate referred to by its approximate weight per square foot for a specified thickness. For example, 1 in. plate is called 40-pound plate. This was determined by dividing one cubic foot of steel (490 pounds) by 12, which gives you 40.8 for one square foot. In practice, the .8 is dropped for convenience.



11.33
Figure 9-1.—Steel bars.

Figure 9-2 shows the weight (approximate) of plate for varying thicknesses.

Large steel plates are used where strength and watertightness are of primary importance, such as in shipbuilding, storage tanks, and pontoon construction. Small plates are generally recut to various shapes to form connections between other members or to be used as component parts of built-up structural members. Plates with a raised pattern to resist skidding or slipping are called FLOOR PLATES.

Rolled Steel Shapes

Common structural rolled steel shapes are the wide-flange beam, I-beam, channel, tee, and angle (see figs. 9-3 and 9-4). Another name for the wide-flange beam is H-beam. Angles are either EQUAL-LEG or UNEQUAL-LEG as shown. Notice that it is easy to identify the various shapes by the "letters" formed by their cross sections; e.g., "I" for I-beam, "C" for channel, "L" for angle, and so on.

Beam and channel are designated as to size by the nominal depth of the web in inches and the weight per linear foot. For example, a wide-flange beam with a web depth of 12 in. and weight of 27 pounds per foot would be designated 12 WF 27. Steel angles are designated by the width and thickness of the legs in inches, such as L 6 x 4 x 5/8. Structural tees (ST) are proportionately the same size as either wide-flange or I-beams, and they are designated by the depth in inches and also by the weight per foot. A structural tee from a wide-flange which is 18 in. deep and which weighs 115 pounds per foot would be designated ST 18 WF 115.

You can learn a lot about structural shapes by observing how they are placed in various types of steel structures. You will find, for instance, that wide-flange beams are used, not only as

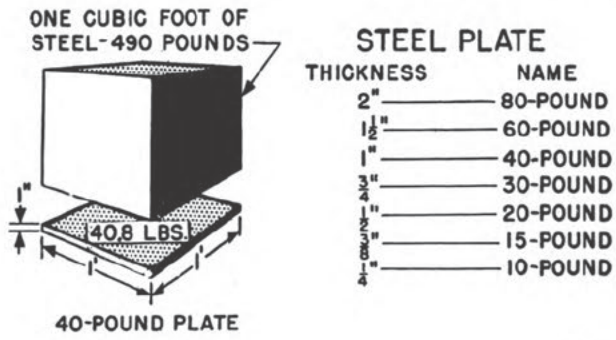


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Figure 9-2.—Weight and thickness of steel plate.

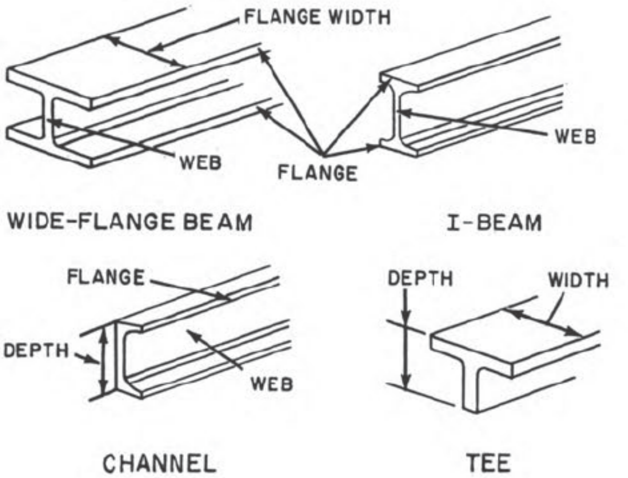

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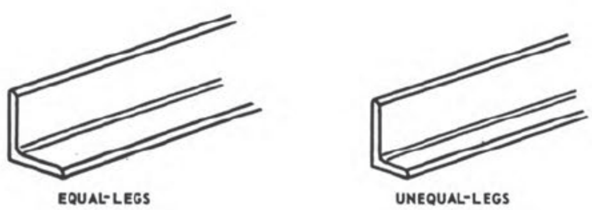
Figure 9-3.— Four common structural rolled steel shapes.



11.31
Figure 9-4.— Angles.

beams, but also as columns. Beams and channels are used principally as "load-bearing" members, although channels may be used as bracing members as well. An angle used alone is usually a bracing member, but pairs of angles, joined back to back to form "tees," may also be used as load-bearing members.

Steel Pipe and Structural Tubing

Steel pipe for structural purposes is available in diameters up to 12 inches and in three weights: standard weight, extra strong, and double-extra strong. Structural tubing is either square or rectangular in shape with a maximum dimension of 12 inches. Both structural pipe and tubing are primarily used as load-bearing columns. Some designs call for these to be filled with concrete for additional strength.

STEEL STRIPS AND SHEETS

Flat steel having dimensions less than those previously specified for steel bar or plate are classified as either STEEL STRIP or STEEL SHEET, depending again on the respective width and thickness. In addition, both are currently being designated by a United States Standard Gage Number, which is officially a weight gage in ounces per square foot. U.S. Standard Gage Numbers are shown in Table 3-2 of Tools and Their Uses, NavPers 10085-B.

Steel strip is 12 in. or less in width with a maximum nominal thickness of 3/16 in. (actual maximum thickness is .2299 in.). Steel sheet, commonly called "sheet metal," is over 12 in. wide and it too has a maximum nominal thickness of 3/16 in. Steel strip and sheet are generally reworked into many useful products, such as ductwork, containers, cabinets, and so on. Various types of sheets are used as metal sheathing for structures and partitions.

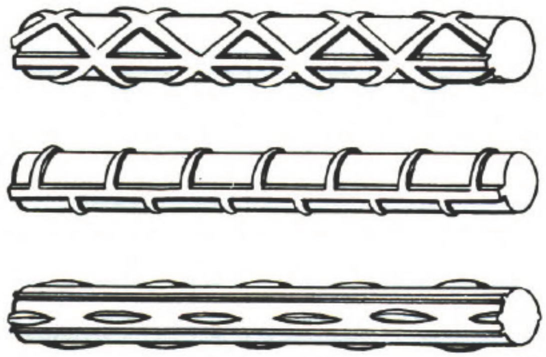
CONCRETE REINFORCING STEEL

Concrete is high in compressive strength (capacity for resisting a crushing force) but low in tensile strength (capacity for resisting a bending, stretching, or twisting force). However, the tensile strength of concrete can be considerably increased by the use of reinforcing steel embedded in the material. Consequently, any concrete which must sustain bending, stretching, or twisting forces (such as the concrete in retaining walls, beams, columns, and the like) is usually reinforced.

Load-bearing concrete members are usually reinforced with steel reinforcing bars, commonly called rebars. These may be plain-surfaced, but are usually "deformed" (fig. 9-5) to improve the bond between the concrete and the metal.

Slab concrete, as in a highway, is usually reinforced with screen-like sheets of welded-wire mesh.

Reinforcing steel is set up and tied in the forms before the concrete is poured. Bars must be cut, bent, and placed in accordance with requirements indicated on the working drawings, and this is done by Steelworkers. Bars are cut with power shears or a gas cutting torch using oxygen with acetylene or methylacetylene propadiene (MAPP)



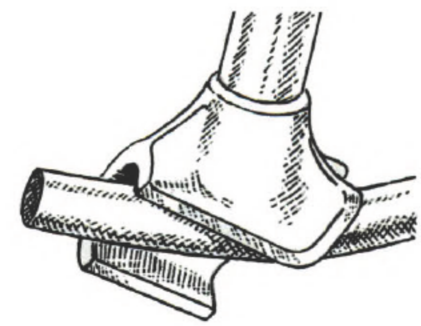
29.182
Figure 9-5.—Deformed reinforcing bars.

gas. There are various hand and power devices for bending. A hickey, like the one shown in view A of figure 9-6, is an effective hand device for bending bars, when the bars have to be bent in place. By placing the jaws of the hickey on one side of the center of the bend, and pulling on the handle, it is possible to produce a smooth, circular bend through almost any angle that is desired. When a hydraulic reinforcement bar bender, like the one shown in view B of figure 9-6, is available, it can be used to bend bars cold up to a 2-inch diameter. Figure 9-7 shows Steelworker students at NavScon, Davisville, demonstrating the installation of rebars for a column with footing.

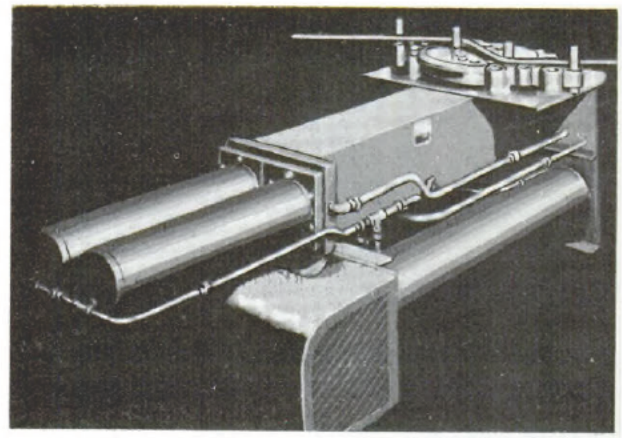
STEEL MATERIALS HANDLING

Heavy steel members are usually unloaded from trucks or railroad cars by fork lift truck, or by truck-mounted or crawler-mounted cranes. If none of these are available, a gin pole may be rigged as explained later in this chapter. Lighter members may be unloaded by hand, in which case they should be "skidded" to the ground as shown in figure 9-8. Steel members should never be thrown or dropped from the car.

Members should be grouped by sizes and piled on steel or timber dunnage as shown in figure 9-9. Groups which are to be hoisted together are separated by blocking so that slings may be passed around them. Steel which will remain for a long time in a storage pile should be protected against the weather, or at least piled so that it will drain readily.



(A.)-HICKEY.



(B.)-A 2-INCH CAPACITY AUTOMATIC REINFORCEMENT BAR BENDER.

29.183:127.78
Figure 9-6.—Devices for bending reinforcing bars.

WIRE ROPE AND FIBER LINE

In handling heavy steel members and equipment, the Steelworker will do a lot of rigging. He may rig A-frames, gin poles, derricks, hoists, booms, and special tackle to move and hoist steel members and equipment. Since wire ropes and fiber lines are indispensable in this type of work, the Steelworker must know a few things about them.

CONSTRUCTION OF WIRE ROPE

Wire rope consists of wires, strands, and a central core, as illustrated in figure 9-10. In the manufacturing process a number of wires are twisted together to form the strand, and a

29.421
Figure 9-7.—Steelworker students demonstrating the proper placement of rebars for a column with footing.

number of strands are twisted around the central core to form the rope. The central core may be a hard fiber (such as manila, hemp, or sisal), a wire strand, or an independent wire rope. Each type of core serves the same basic purpose, that of affording support to the strands laid around it.

A wire rope is classified according to the number of strands and the number of wires in each strand; a 6 x 19 rope, for instance, contains 6 strands, each of which contains 19 wires. The Navy uses wire rope with from 6 up to 37 wires to a strand. Flexibility increases with the number of wires to a strand. Wire rope is designated as to size by diameter in inches.

WIRE ROPE GRADES AND LAYS

Three commonly used grades of steel wire rope are plow steel, mild plow steel, and improved plow steel. Most of the steel wire rope used by Steelworkers is improved plow steel, which is tougher, stronger, and more wear-resistant than either plow steel or mild plow steel.

In regards to wire rope, the terms "right lay" and "left lay" relate to the direction in which the strands are twisted. In right-lay rope this direction (as you look along the rope) is clockwise; in left-ray rope it is counterclockwise.

The terms "regular lay" and "lang lay" relate to the direction of twist of the wires in a strand. If this direction is the opposite to that of the strands in the rope, the rope is regular-lay; if it is the same, the rope is lang-lay.

WIRE ROPE HANDLING AND CARE

You will find that wire rope has a strong tendency to kink during uncoiling or unreeling, especially if it has been in service for a long time. Keep in mind that a kink can cause a weak spot in the rope, which will wear out quicker than the rest of the rope.

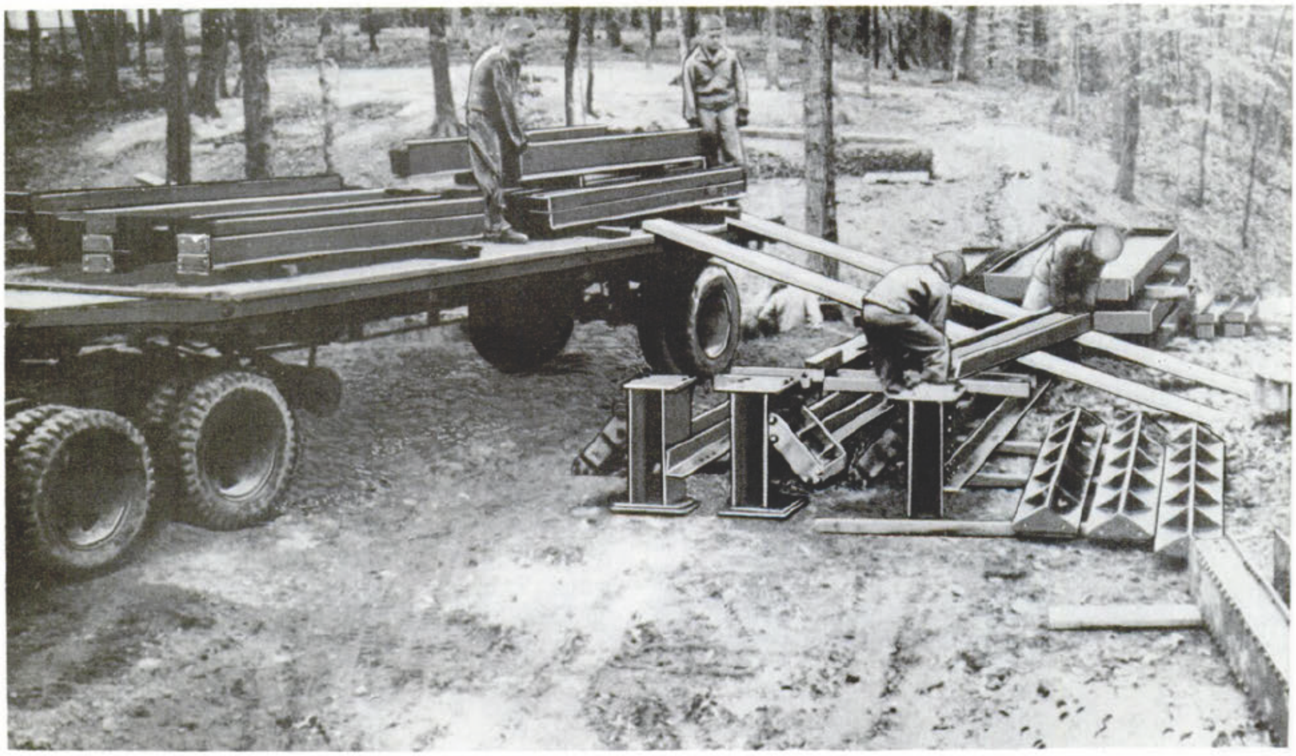
A good method for unreeling wire rope is to run a pipe or rod through the center and mount the reel on drum jacks or other supports so that the reel is off the ground (see fig. 9-11, left). In this way the reel will turn as the rope is unwound, and the rotation of the reel will help keep the rope straight. During unreeling, pull the rope straight forward, as shown in figure 9-11 (left), and try to avoid hurrying the operation. As a safeguard against kinking, NEVER unreel wire rope from a reel that is stationary.

To uncoil a small coil of wire rope, simply stand the coil on edge and roll it along the ground like a wheel or hoop, as illustrated in figure 9-11 (right). NEVER lay the coil flat on the floor or ground and uncoil it by pulling on the end, because such practice is likely to cause kinks or twists in the rope.

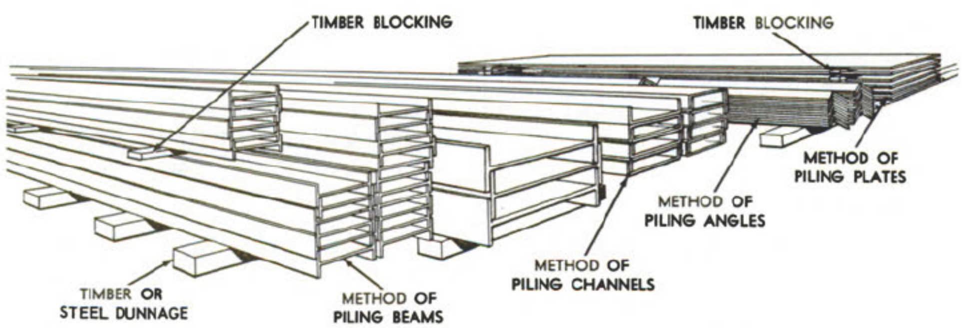
To re-reel wire rope back onto a reel or a drum, you may have difficulty unless you remember that it tends to roll in the opposite direction of the lay. A right-lay wire rope, for example, tends to roll to the left.

Any wire rope — even a new one — may contain an occasional FISHHOOK, or protruding end of a wire. If a fishhook should slide through your bare hand, it will give it a very nasty cut. ALWAYS WEAR GLOVES whenever you are handling wire rope.

Make sure that wire rope has been cleaned and lubricated properly before it is placed in storage; while you may not handle the cleaning and lubricating operations, see that they have been done. Fortunately, corrosion of wire rope



29.168
Figure 9-8.—Use of skids for unloading steel.

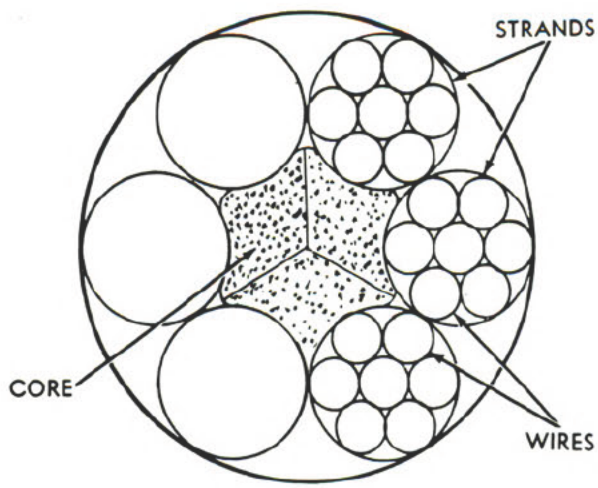


29.169
Figure 9-9.—Method of piling steel members.

during storage can be virtually eliminated, IF the lubricant film is applied properly beforehand and if adequate protection is provided from the weather. Bear in mind that rust, corrosion of wires, and deterioration of the fiber core will greatly reduce the strength of wire rope. It is not possible to say exactly the loss of strength which results from these effects. It is certainly great enough, however, to require close observance of those precautions prescribed for protection against such effects.

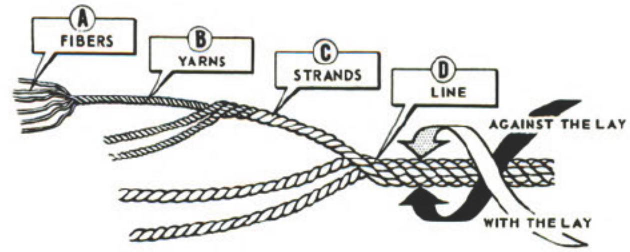
TYPES OF FIBER LINE

Fiber line is made from the fibers of various plants. Manila line, made from the fibers of

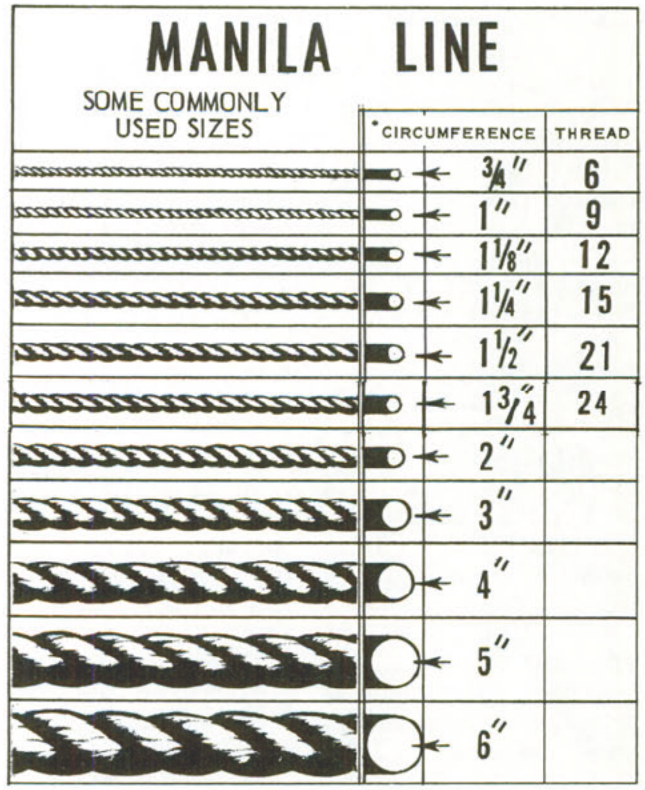


29.172
Figure 9-10.—Parts of a wire rope.

29.174
Figure 9-11.—(Left) Unreeling wire rope. (Right) Uncoiling wire rope.



29.170
Figure 9-12.—Makeup of 3-strand fiber line.



* SIZE IS DESIGNATED BY THE CIRCUMFERENCE

127.40
Figure 9-13.—Some commonly used sizes of manila line.

the abaca plant of the Philippines, is the best quality fiber line. Sisal line, made from the fibers of the African sisal plant, is next in quality. After sisal comes hemp, a plant native to America.

Fiber line is made up as shown in figure 9-12.

In the Navy, a line that is 1 3/4 inches or less in circumference is called SMALL STUFF, and is usually designated as to size by the number of THREADS (or yarns) that make up each strand. A line larger than 1 3/4 inches in circumference is generally designated as to size by its CIRCUMFERENCE in inches (see fig. 9-13).

You may hear some small stuff designated by name, without reference to size by thread. One type is MARLINE, a tarred, 2-strand, left-laid hemp. Marline is the small stuff which is commonly used for seizings. Rope yarns may also be used for temporary seizings, whippings or lashings.

Incidentally, at some activities you may have occasion to use nylon line. The breaking strength of nylon line is almost three times that of manila line of the same size. Nylon line also is lighter, more flexible, less bulky, and easier to handle and stow than manila line. When nylon is stretched more than 40 percent, however, it is likely to part. The stretch is immediately recovered with a snapback that will sound like a pistol shot. The snapback can be as deadly as a bullet. It is, therefore, imperative that no one stand in the direct line of pull when a heavy strain is applied. This is also true for other types of lines, but overconfidence in nylon's strength may lead one to underestimate its backlash.

FIBER LINE HANDLING AND CARE

If a coil of line, as received from the manufacturer, is opened the wrong way, there will be a kink in the line for every turn in the coil. Coils which can be mounted on an axis (such as a piece of pipe) for revolving can be unwound from the outside end like wire. To uncoil a coil that is not on a stand, simply grasp the end of the line inside the coil (at the bottom) and pull it up through the CENTER, bringing it out from the front towards you.

A "right-laid" line is one in which the strands twist clockwise as you look along the line. Most of the line used in the Navy is right-laid, but there is some "left-laid" around. ALWAYS coil down a right-laid line clockwise. Coil down a left-laid line counterclockwise.

All fiber line will shrink as it becomes damp and expand again when it dries out. Consequently, a dry, taut line secured at both ends must be slacked when it becomes damp; otherwise, the stress will strain the fibers.

A line which will be subject to a strain must not be allowed to bear against a sharp edge which might chafe through the fibers. If the line must be led over a sharp edge, a fender (such as a block of wood) must be placed to protect it from chafing, or the line must be wrapped with canvas (called chafing gear) at the danger point.

A fiber line must never be exposed to acids or other chemicals. It must not be stored in a room containing chemicals as the fumes from the chemicals may damage the line.

Line stowed in a damp, unventilated space will deteriorate. Whenever possible, line should be well dried before it is stowed away. The compartment where line is stowed must be dry and well ventilated, and line stowed therein should be coiled down on gratings raised off the deck, or it should be hung on pegs.

RIGGING

Much load-lifting in Navy construction is done by cranes operated by the Equipment Operators. In the absence of a crane, however, such lifting rigs as gin poles and tripods, from which tackles for lifting are hung, must be set up. The setting up of these devices is called RIGGING.

BLOCK AND TACKLE

A block and tackle (sometimes shortened to just plain tackle) consists of a line or wire (called the fall) reeved through one or more blocks. The parts of a block are shown in figure 9-14. A tackle with a movable block provides a mechanical advantage — meaning that it multiplies the power applied to the hauling part of the fall. The parts of tackle are shown in figure 9-15.

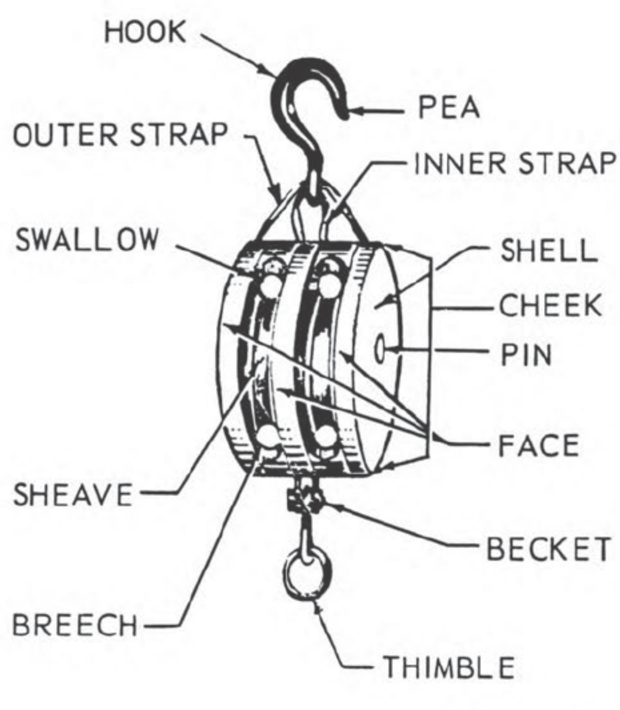


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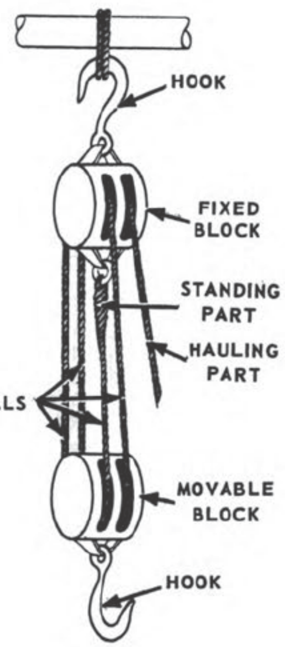
Figure 9-14.—Nomenclature of a fiber rope block.



29.187(127)B
Figure 9-15. — Parts of a tackle.

Mechanical Advantage

The mechanical advantage of a tackle is expressed in terms of the number of times the applied power is multiplied. The theoretical mechanical advantage may be determined by counting the number of parts of the fall above the MOVABLE block. For the tackle shown in figure 9-15 the theoretical mechanical advantage is 4, there being 4 parts of the fall on the movable block. This means that in theory an applied power at the hauling part of 100 pounds would lift a 400-pound load hung on the hook of the movable block.

A certain amount of the force applied to a tackle is lost through friction. Friction will develop in a tackle by the lines rubbing against each other, or against the shell of a block. Friction also is caused by the passing of the line over the sheaves, or by rubbing of the pin against the sheaves. An adequate allowance for the loss due to friction must be added to the weight being lifted in determining the power required to lift a given load. Roughly, 10 percent of the load must be allowed for each sheave in the tackle.

When lifting the 400 pound load mentioned above you must add the 10 percent for each sheave and this would be 40 percent when using the twofold purchase. Multiply .40 x 400 and you get 160 pounds, which you add to the 400 and you get 560 pounds.

Dividing the 560 by 4 you get 140 pounds, which is the power required to lift the load.

Types of Tackle

Tackles are designated according to (1) the number of sheaves in the blocks that are used to make the tackle, or (2) the purpose for which the tackle is used. Three commonly used tackles are shown in figure 9-16. Several setups or combinations of blocks and tackles may be made to attain the desired mechanical advantage. Described below are some of the types of tackle which you may encounter in the Navy.

A tackle which consists of one single-sheave block fixed to a support with a line passing over the sheave is called a SINGLE WHIP tackle. This setup derives no mechanical advantage.

A single-sheave movable block that is free to move along the line on which it is rove is called a RUNNER. This setup has a mechanical advantage of 2.

A GUN TACKLE (fig. 9-16) is made up of two single-sheave blocks and got its name by being used in the old days to haul muzzle-loading guns back into battery after the guns had been fired and reloaded. This also has a mechanical advantage of 2.

A SINGLE LUFF TACKLE consists of a double and a single-sheave block, as shown in figure 9-16. This type has a mechanical advantage of 3.

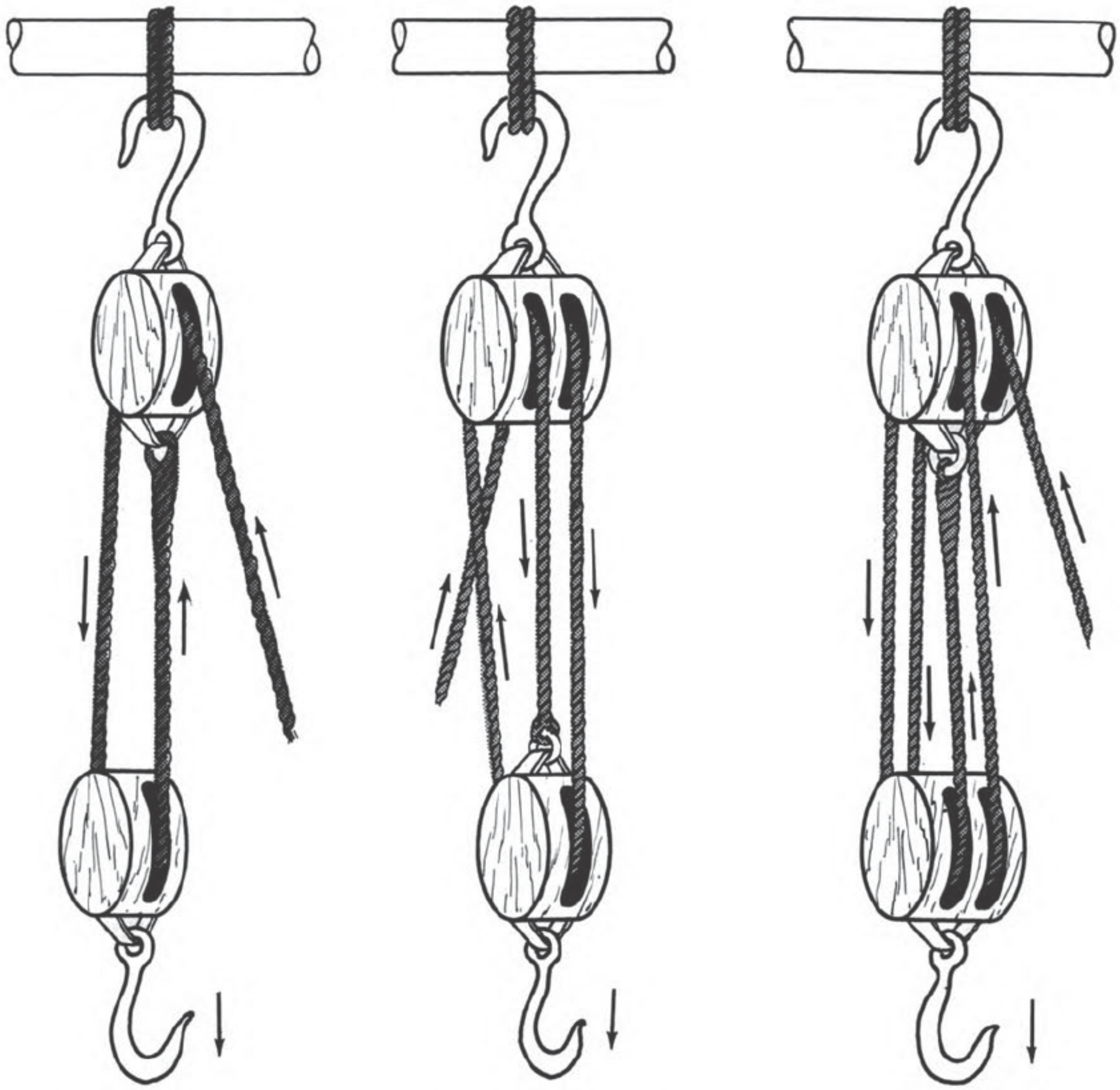
A TWOFOLD PURCHASE consists of two double-sheave blocks (also shown in fig. 9-16). As you can see, this type has a mechanical advantage of 4.

A DOUBLE LUFF TACKLE (not shown) has a fixed triple-sheave block and a movable double-sheave block. This type has a mechanical advantage of 5.

A THREEFOLD PURCHASE (also not shown) consists of two triple-sheave blocks and has a mechanical advantage of 6.

SLINGS AND STRAPS

In most cases, Steelworkers' materials such as structural steel shapes are hoisted by wrapping a length of line or wire around the article or articles and slinging the line or wire to the hoisting hook. Generally speaking, a SLING is an "endless" line or wire, spliced to itself



29.187
Figure 9-16.—Three common types of tackle.

as shown in figure 9-17, while a length of line or wire with an eye splice in each end (fig. 9-18) is called a STRAP. Figure 9-19 shows a chain sling.

GIN POLES, SHEARS, AND TRIPODS

An elevated point at which to hang the upper block of a tackle for hoisting a load may be attained by erecting a gin pole, a set of shears, or a tripod.

A gin pole (fig. 9-20) is a single timber or steel member, raised to a nearly vertical angle and held in place by "guys" of line or wire, running from the head of the pole to anchoring points on the ground. A gin pole requires a minimum of one after guy and two side guys. A set of shears (fig. 9-21) actually requires only an after guy to sustain the load. However, a forward guy is usually rigged as well, to hold

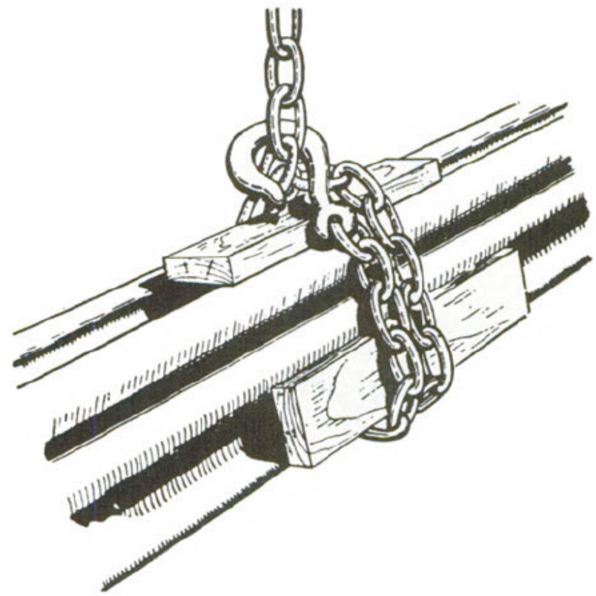
29.190
Figure 9-17. — Ways of hitching on slings.

29.191
Figure 9-18. — One way of hitching on a strap.

the rig steady in the absence of a load. A tripod (fig. 9-22) needs no guys, but is incapable of moving the load laterally over the ground.

ANCHORING GUYS

Guys for gin poles and shears are commonly anchored to natural holdfasts, picket holdfasts, or buried deadmen. Figure 9-23 shows how a pair of trees can be used as a natural holdfast. A rock holdfast is a natural holdfast made by



29.192
Figure 9-19. — Chain sling.

inserting a pipe, crowbar, or steel picket in a hole drilled in solid rock. A single-picket holdfast consists simply of a driven stake. Figure 9-24 shows combination picket holdfasts.

A "deadman" is simply a timber, steel beam, or similar object, buried in a trench dug at right angles to the line of direction of the guy. The guy is made fast to the midpoint on the deadman.

RIGGING SAFETY

When assisting with the hoisting or moving of heavy objects using blocks and tackle or a crane, keep SAFETY uppermost in mind — not only for yourself, but also for your coworkers and the materials being hoisted or moved. Again, you are under supervision, but remember that safety is everybody's business in any type of work. Be alert at all times and observe closely the movements of the object being hoisted or moved; watch for any loose connections or materials in the rigging arrangement. Observe the lines, blocks and tackle, slings, straps, hitches, supporting poles or booms, guys, and what have you, for any sign of weakness or danger and report same immediately to your supervisor; even if in doubt, report it any way for proper examination by a trained eye.

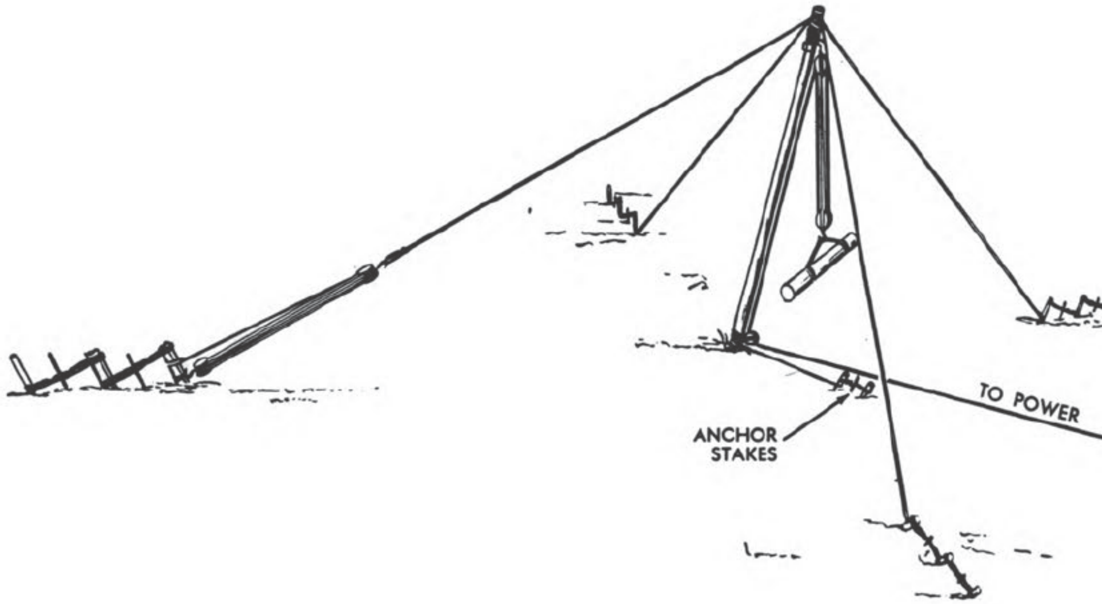


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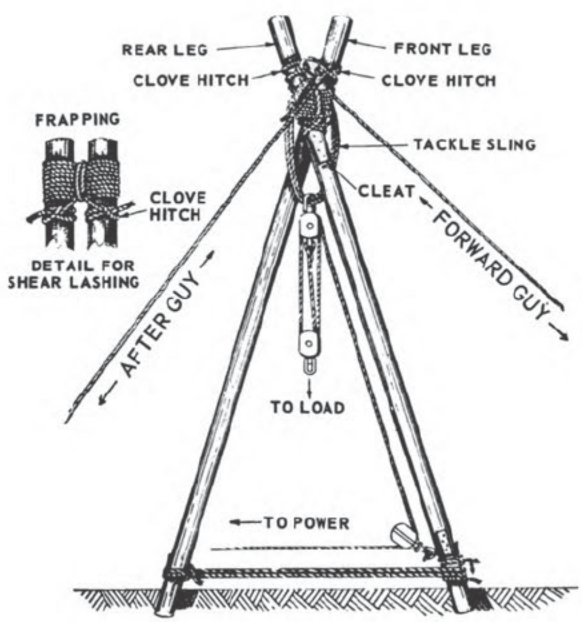
Figure 9-20. — Gin pole.



29.195
Figure 9-21. — Shears.

If a crane is being used, be sure you remember and understand the meanings of the hand signals given in chapter 3 of this training manual. Stay away from the object being moved once it is ready for hoisting. Watch for powerlines nearby that the Equipment Operator may not be aware of. Hard hats, gloves, and safety shoes must be worn at all times in this type of work.

WELDING

"Welding" means the process of joining metals by "fusing" them together by the application of intense heat. In the gas welding process the heat is provided by a torch which burns a mixture of oxygen and acetylene or oxygen and MAPP gas. In the electric arc process the heat is provided by an electric arc.

WELDING MATERIALS

Besides the two metals to be joined, welding involves the use of a "filler" metal which forms the joining "bead." To bring the filler metal into intimate contact with the metals being joined, a "flux" may be used.

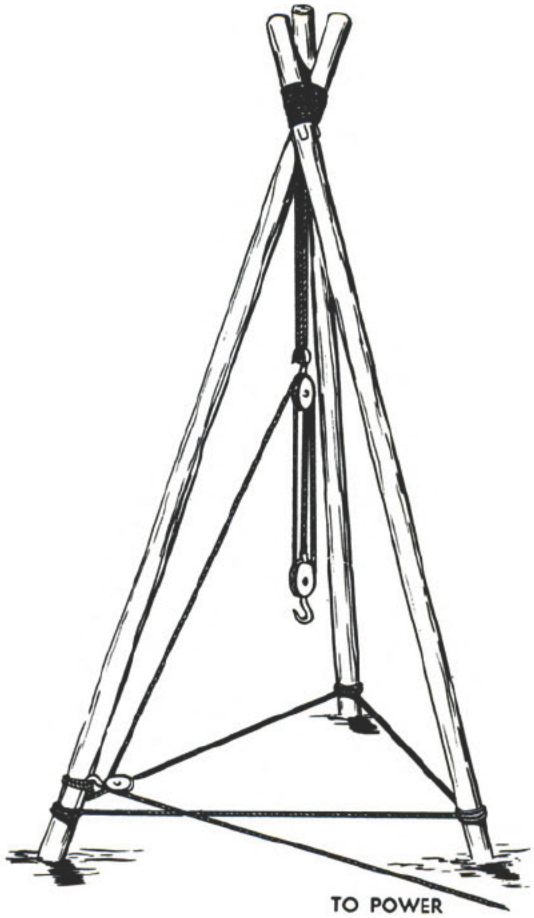


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Figure 9-22. — Tripod.

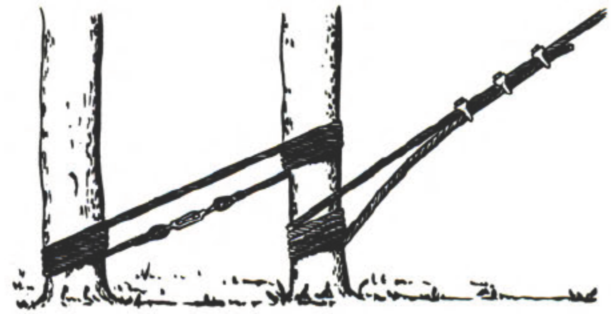

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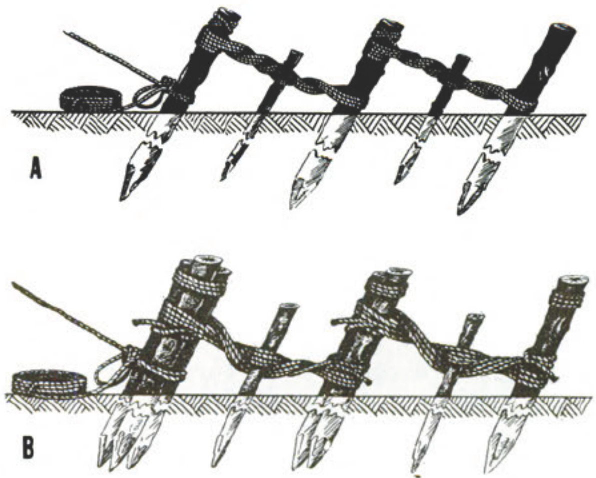
Figure 9-23. — Trees used as natural holdfast.



29.198
Figure 9-24. — Combination picket holdfasts.

Fluxes

A flux is a fusible (easily melted) material used to dissolve, and thus aid in removing, oxides and other undesirable substances from the weld joint area. Fluxes are available in paste, powdered, and liquid form. Powders can be sprinkled on the base metal, or the filler rod can be heated and dipped into the powder. Liquid and paste fluxes may be applied to the filler rod and to the base metal with a brush.

No single flux is satisfactory for universal use. The composition of the flux depends chiefly upon the nature of the base and filler metals.

Nearly all fluxes give off fumes which may be toxic in a non-ventilated or poorly ventilated space. They should therefore only be used in a well-ventilated atmosphere. However, any welding operation requires adequate ventilation, whether a flux is used or not.

Filler Metals

"Welding rod" is a filler metal, in wire or rod form, which is used mainly in the gas welding process. However, it may also be used in certain electric welding processes in which the filler metal does not form part of the electric circuit (in the ordinary electric-arc method a filler metal usually does). The sole purpose of a welding rod is to supply filler metal to the joint.

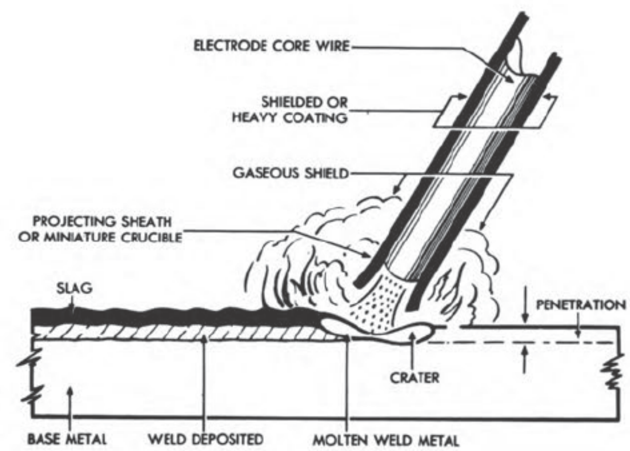
Most gas welding rods for steel welding come in 36 inch lengths, and in diameters ranging

from 1/32 to 3/8 inch. Gas welding rods for cast-iron welding run from 18 to 24 inches in length, and are often square rather than circular in cross section.

Some rods are specifically designed for welding ferrous metals, others for welding nonferrous metals. The average shop keeps "brazing alloys" which can be used for either ferrous or nonferrous metals.

In electric-arc welding the part of the apparatus which contacts the metals to be joined is a current-carrying rod-shaped "electrode." An electrode may or may not be a source of filler metal supply as well. A great variety of electrodes are available for electric-arc welding of both ferrous and nonferrous metals.

An electrode may be bare, or it may be lightly or heavily covered with either a cellulose or a mineral type of coverage, or with a combination of both. A cellulose coverage, as it burns, forms a gaseous "shield" around the arc stream and places a slag covering over the weld. A heavy coating on an electrode provides a projecting sheath or "miniature crucible" as the electrode is consumed, as shown in figure 9-25.



11.71

Figure 9-25.—Action of shielded arc or heavy-coated electrode.

Acetylene

Acetylene is a flammable gas made up of carbon and hydrogen. When burned with oxygen it produces a very hot flame (from 5700° to 6300°F). The gas is dissolved in "acetone" (a liquid), and compressed in a cylinder filled with some porous material such as balsa wood, charcoal, shredded asbestos, corn pith, or portland cement. Pure acetylene, when stored in a free state under a pressure of 29.4 pounds per square inch (psi), becomes a self-explosive. Dissolved in acetone, however, it can be compressed into cylinders at pressures up to 275 psi.

MAPP Gas

MAPP (methylacetylene propadiene) gas can be used as a substitute for acetylene. It is burned with oxygen and is used in various working operations, such as cutting, heating, welding, etc.

Oxygen

Oxygen is a colorless, tasteless, and odorless gas that is slightly heavier than air. It will not burn by itself, but will support combustion when combined with combustible material. In the oxy-acetylene or oxy-MAPP welding process, the addition of the oxygen causes the acetylene and MAPP gases to burn with much greater heat.

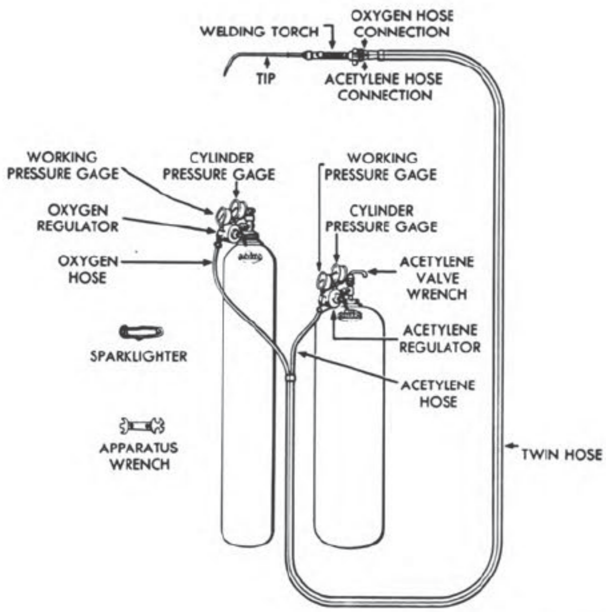
OXYACETYLENE WELDING EQUIPMENT

In its simplest form, an oxyacetylene welding outfit consists of a cylinder of acetylene, a cylinder of oxygen, two regulators, two lengths of hose with fittings, and a welding torch body with tips. A number of accessories are also usually part of the outfit, such as a spark igniter for lighting the torch; an apparatus wrench which fits the various connections on regulators, cylinders, and torches; goggles with filter lenses for eyesight protection; and gloves for hand protection.

Figure 9-26 shows a typical portable oxy-acetylene welding outfit. A stationary outfit is one in which the gases are piped from a stationary bank of cylinders to a number of welding stations.

The gas pressure in a cylinder must be reduced to a suitable working pressure before it can be used. This pressure reduction is accomplished by a "regulator" or reducing valve (fig. 9-26). A "single-stage" regulator reduces the pressure in one step, a "two-stage" regulator in two steps.

A regulator includes pressure gages which indicate pressure in the cylinder or pipeline



11.96X

Figure 9-26.—Portable oxyacetylene welding outfit.

(inlet) and working pressure (outlet). Acetylene regulators and oxygen regulators are of the same general type, but those designed for acetylene are not made to withstand as high pressures as those designed for oxygen.

A torch has two needle valves, one for adjusting flow of oxygen, the other for adjusting flow of acetylene. Other parts of the torch are the handle, two tubes (one for oxygen, the other for acetylene), the mixing "head," and the tip.

Tips and mixers are designed in different ways by different manufacturers. Some torches have separate mixing heads or mixers for each size of tip. Others have only a single mixer for several tip sizes. Tips of hard copper, brass, or bronze come in various types. Some are one-piece; others are two-piece and include an extension tube to make the connection between the tip and the mixing head. A tip is designated as to size by the diameter of the hole, but manufacturers use their own numbering systems to designate holes of various diameters.

The hose which connects the torch to the regulators is strong, nonporous, and sufficiently flexible and light to make handling the torch easy. It is made to withstand high internal pressure, and the rubber is specially treated to remove sulphur and avoid danger of spontaneous combustion.

Oxygen hose is colored green, acetylene hose red.

CAUTION: No oil, grease, or other lubricant must ever be used on oxyacetylene welding apparatus. In the presence of oxygen, such material will ignite violently.

OXYACETYLENE CUTTING TORCH

When extra high-pressure oxygen is added to the oxyacetylene flame, the flame can be used for cutting metals. To convert the apparatus for cutting, the welding torch may be replaced by a standard cutting torch. The cutting torch has an extra tube for the cutting oxygen, and a trigger for turning it on during actual metal cutting.

Some welding torches are equipped so that the welding head can be removed and a "cutting attachment" attached as shown in figure 9-27. The additional high-pressure oxygen is introduced by pressing down the handle shown.

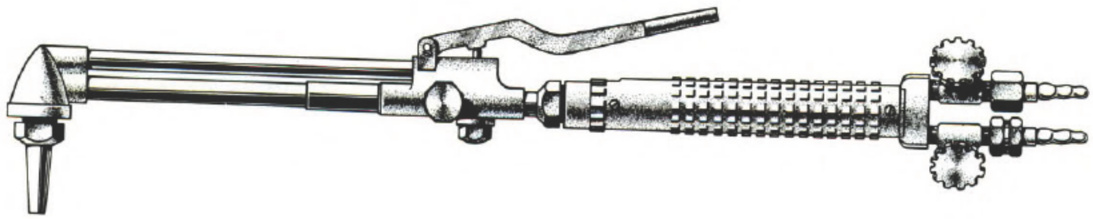
The cutting tip or nozzle on a cutting torch or cutting attachment is made with a number of orifices (openings) as shown in figure 9-28. The jet or stream of oxygen that does the cutting comes from the center orifice. The smaller preheat orifices emit oxyacetylene heating flames. These preheat the metal to the kindling temperature, and then the oxygen jet burns it away or "cuts" the metal.

ARC-WELDING EQUIPMENT

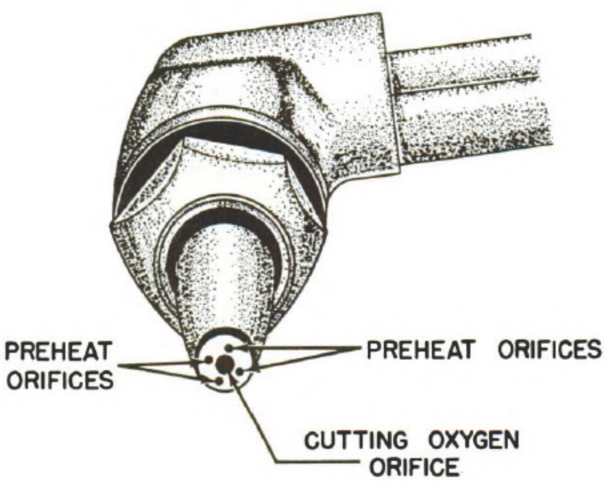
A wide variety of arc-welding equipment is available, and there are many differences in make and model in the equipment produced by different manufacturers. However, the basic function of any arc-welding equipment is to produce high-current, low-voltage electric power at the electrode.

An arc-welding outfit consists basically of the welding machine (essentially a generator or a transformer), the cables which transmit power from the machine to the electrode holder, the electrode holder, and the electrodes. Accessories include a combination hammer and wire brush, C-clamps, and such personal protective apparel as a helmet or face shield and a pair of leather gloves.

Figure 9-29 shows equipment which includes a 300-ampere, gasoline engine-driven welder.



11.126
Figure 9-27.—Cutting attachment on a welding torch.



11.127X
Figure 9-28.—Cutting tip, showing preheat orifice.

The generator on a welder may produce direct current (d-c) or alternating current (a-c). A d-c welder consists of a d-c generator plus a prime mover which may be an a-c or d-c electric motor or a gasoline or diesel engine. The current for an a-c welder may be produced by an a-c generator or it may be obtained from a transformer.

The cables which carry current from the power source to the electrode holder must have sufficient current-carrying capacity; good insulation; provision for coupling to the welder, to ground clamp, and to the electrode holder; flexibility; and durability.

An electrode holder, familiarly known as a stinger, is an insulated clamping device for holding the metallic electrode. It is designed to hold the electrode securely in any position, and to permit quick and easy change of electrodes. Typical electrode holders are shown in figure 9-30.

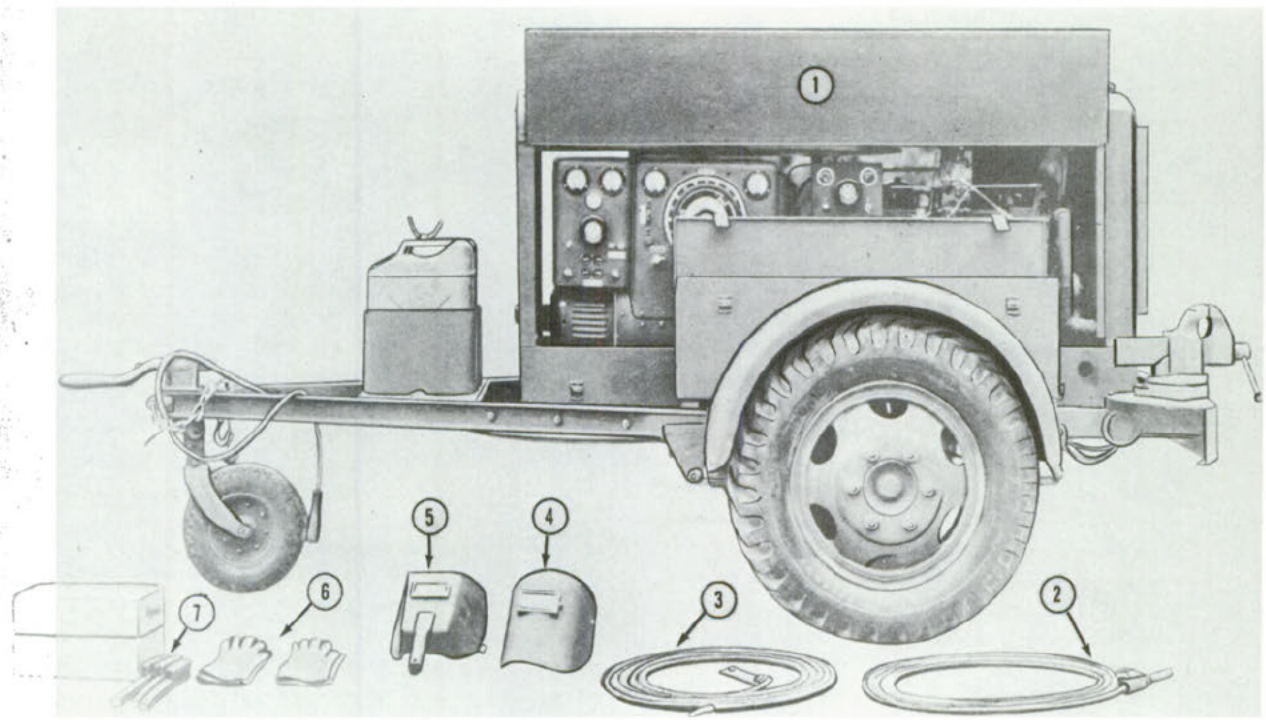
PERSONAL PROTECTIVE EQUIPMENT

Eye protection is of the utmost importance, not only for individuals doing actual welding or cutting, but also for any other personnel in the vicinity of welding or cutting operations—such as helpers (in steelwork, as elsewhere, the CN functions principally as a helper), chippers, and inspectors. Eye hazards include stray flashes, reflected glare, flying sparks, and flying globules of molten metal.

Devices used for eye protection include helmets, hand shields, and goggles. There are two general types of goggles in common use. One is a spectacle type (fig. 9-31), furnished with or without metal side shields. The other is an eye cup or cover type with flexible connected lens containers shaped to conform to the configuration of the face. The cover type is designed for wearing over corrective eyeglasses.

Goggles should be worn during all gas-welding operations. For operations near or above eye level, only the eyecup or cover type goggles should be used.

For eye protection during electric-arc welding, a helmet or hand shield with a suitable "filter lens" is required. (See fig. 9-32.) A filter lens serves two purposes: it reduces the intensity of the arc light enough to eliminate glare and thus make the welding area distinctly visible, and it eliminates the harmful effects of infrared and ultraviolet radiations from the arc. Filter lenses come in a variety of shades, each



1 Trailer-mounted electric-arc welder, 300 amp.
2 Electrode holder and cable.
3 Ground lug and cable.
4 Welder's helmet with lens and cover glass.
5 Welder's hand-held shield with lens and cover glass.
6 Welder's leather gloves.
7 Wire scratch brushes.

29.199
Figure 9-29.— Electric arc-welding equipment.

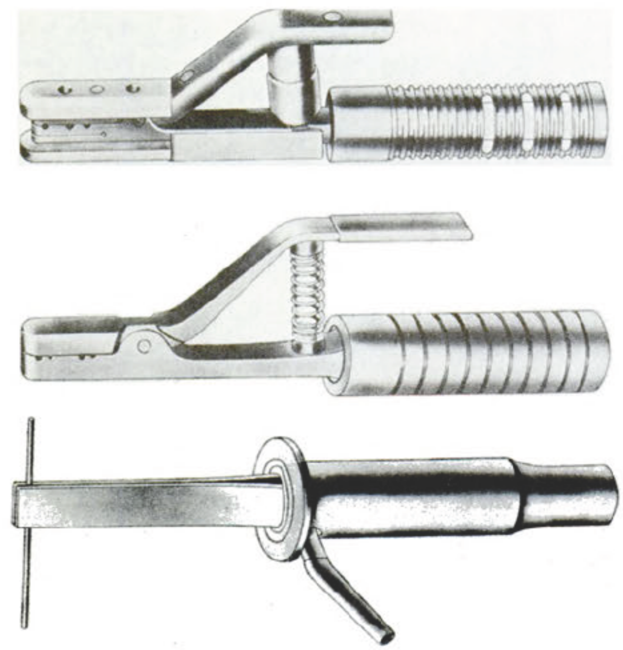
shade being designated by a number. The lower the number, the lighter the shade; the higher the number, the darker the shade.

Helmets, hand shields, and some goggles are made from a nonflammable insulating material. Each filter lens has a clear-glass cover over it, to protect the lens against pitting caused by sparks or hot metal splatter. The clear glass can be replaced when it becomes marked enough to obscure vision.

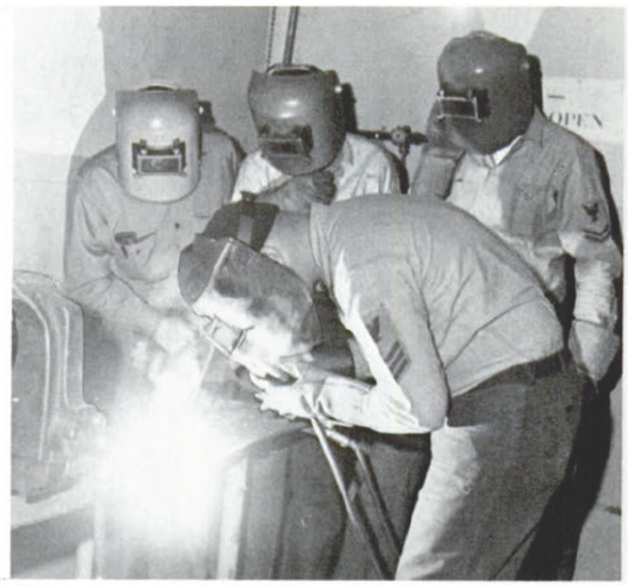
Protective clothing includes leather gloves, cap, sleeves, jackets, and aprons. For gas welding and cutting, a five-finger gauntlet like the one shown in figure 9-33A should be worn. For arc welding, the heavier two-finger gauntlet shown in figure 9-33B is recommended.

Sparks are likely to lodge in rolled up sleeves, pockets of clothing, or cuffs of trousers or overalls. Sleeves should be rolled down and the cuffs buttoned. The shirt collar also should be buttoned. Trousers should not be turned up on the outside, and pockets not protected by button-down flaps should be eliminated from the front of overalls and aprons. All outer clothing must be free of oil and grease. Wear high top or safety shoes; low cut shoes are hazards for sparks and molten metal, especially if you are sitting down.

When metal arc welding is to be done, a portable booth or welding screen will be needed if other persons will be in the immediate area; this will protect them from the ultraviolet rays of the arc. These rays are intense and have a harmful effect upon the eyes.



11.68X
Figure 9-30.— Electrode holders.



29.423
Figure 9-32.— Protective helments worn by Steelworker students at the Steelworkers' School, NavScon, CBC, Davisville, R.I.

29.422
Figure 9-31.— Spectacle-type goggles worn by Steelworker students at the Steelworkers' School, NavScon, CBC, Davisville, R.I.

29.201
Figure 9-33.—Gas and electric welding gauntlets.

METAL FABRICATION

A large part of the Steelworker's job involves fabricating with sheet metal, plates, or reinforcing steel. He may be required to fabricate new items, replacement parts, or pieces to be used in the repair of existing structures. These jobs must be learned by actual performance. They require special tools, equipment, and techniques; they are best learned through formal schooling or through on-the-job training.

METAL SHOPS

On a major construction project which requires the use of several types of steel materials, different metal shops may be set up to handle each type of metal work.

A SHEET METAL SHOP handles maintenance work in which light-gage metal is required. Repairs to metal clad buildings of the advanced base type and fabrication and repair of sheet metal galley equipment are examples of this type of maintenance. The sheet metal shop also supports field construction, by the fabrication of flashings (sheet metal placed around door, window, and other openings to prevent leakage), ducts, metal boxes, and the like.

A REINFORCING STEEL BENDING SHOP may be set up when major concrete construction is in progress. In this type of operation it may be more practical to cut, bend, and otherwise prefabricate reinforcing steel at a central location rather than at the jobsite. A reinforcing shop is devoted entirely to the support of field construction operations.

A WELDING SHOP welds various types of structural steel items, such as frameworks and scaffolds. It also makes welding repairs on automotive equipment, construction equipment, and other machinery.

A STEEL FABRICATION SHOP handles various types of jobs involved in fabrication with sheet metal, plate, and structural shapes. Shop personnel perform such operations as the cutting and drilling required in the erection of steel structures. They also make and repair many types of metal parts used in vehicles, heavy construction equipment, office furniture, and the like.

THE CONSTRUCTIONMAN'S DUTIES IN METAL SHOPS

A metal shop usually contains a toolroom, and as a CN you may be assigned to the toolroom to help out in duties invovling the stowage and care of tools and materials. This will give you an excellent opportunity for learning the nomenclature and proper maintenance of many of the tools used in steelwork.

A well-run toolroom has a specific place for stowage of each tool and each type of material. Always return tools to their proper places, and before you do, perform any required maintenance tasks, such as cleaning and lubricating.

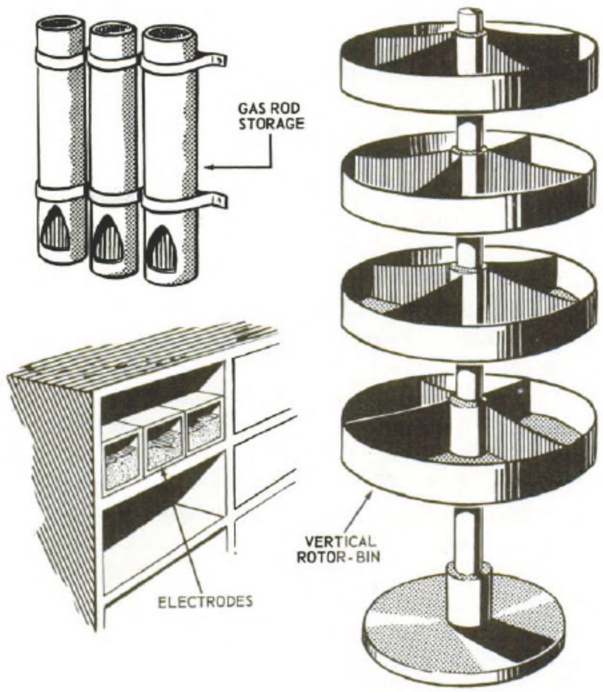
The tools and materials used in the shop and the minimum space required will depend on just what type of metal shop it is. Most any shop, however, requires stowage facilities for screws, bolts, and nuts, and for miscellaneous small fittings. A vertical "rotor-bin" like the one shown in figure 9-34 is excellent for this purpose. Figure 9-34 also shows convenient ways of stowing welding rods and electrodes. Each space should be marked with information identifying the kind of rod or electrode it contains.

Tools may be stowed in drawers, lockers, or cabinets as appropriate. Torch tips, combination squares, gages, and the like must be protected from contact with other tools. Edged tools and such pointed instruments as scribers, dividers, and compasses must be stowed so that edges or points are protected. Precision tools such as micrometers and other measuring instruments must be protected against shock and pressure.

To be both safe and efficient, a shop must be kept in good order, and as a CN shop helper, good housekeeping will be a large part of your duty. Keep tools put away, and keep floors clear of scrap materials, trash, and loose articles such as empty bottles or other containers. Clean up any spilled grease or oil at once, by spreading an absorbing compound (but not sawdust) on it and shoveling or sweeping it up.

STEEL STRUCTURES

Steelworkers erect and dismantle various types of steel structures essential for operations at advanced bases. As a CN, you may be assigned as Steelworkers' helper on projects involving the erection of steel buildings, towers, tanks, and pontoon structures. Again your duties



29.202
Figure 9-34.—Some stowage facilities in a metal shop.

will consist mainly of materials handling, care of tools, and area housekeeping.

The following sections contain brief descriptions of some of the more common advanced base steel structures. If you decide to strike for the Steelworker rating, you will find more extensive descriptions, together with erection procedures, in Steelworker 3 & 2, NavPers 10653, as revised.

BUILDINGS

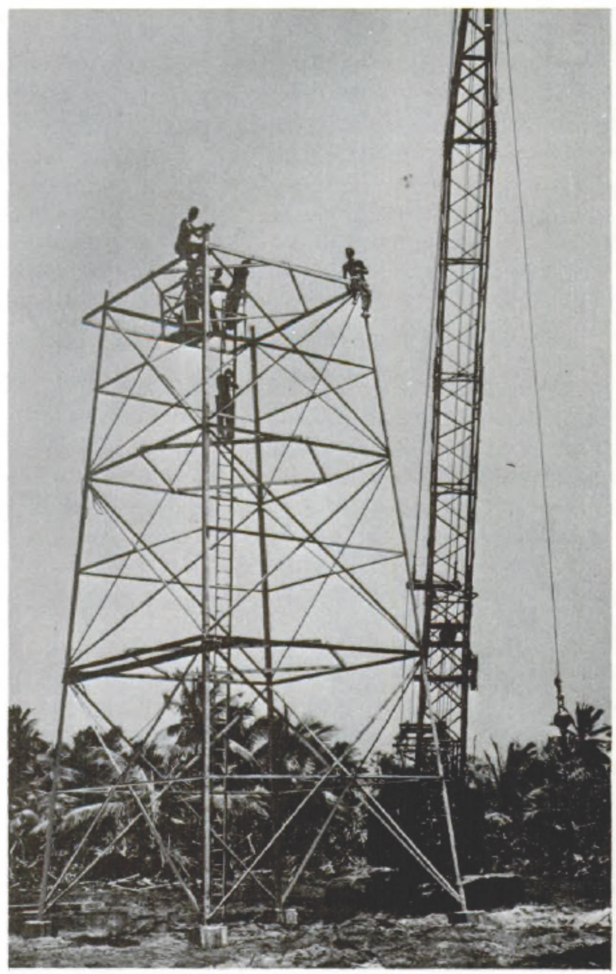
Most of the buildings erected by Steelworkers at advanced bases are preengineered buildings, such as the rigid-frame utility (Butler or Pasco) building. These are prefabricated structures, each consisting of a metal framework covered with metal sheathing.

The basic rigid-frame utility building, known as the Butler building, measures 40 by 100 feet (see fig. 7-49). However, it may be adapted to varying lengths and purposes by subtracting or adding "bays" (a bay consists of a pair of adjacent columns and the sheet metal lying between them), and/or by substituting various foundation and wall sections. The Butler building (named for the manufacturer, the Butler Manufacturing Company) is used principally as a shop or warehouse.

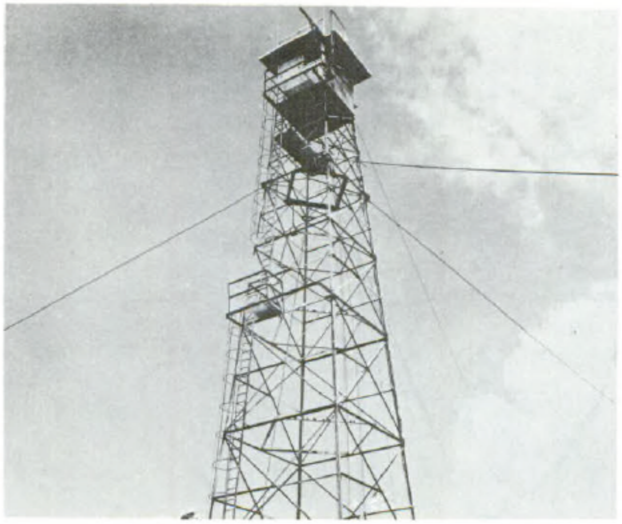
TOWERS

Steel-frame control towers, radio towers, water-tank towers, and the like are prefabricated and packaged according to military specifications and assembled in the field by Steelworkers. A partially completed tower is shown in figure 9-35.

The upper portion of a completed control tower is shown in figure 9-36. This tower has an "open" frame, consisting of structural steel shapes, bolted together. The frame rests on



127.121X
Figure 9-35.—Partially erected tower.



29.178
Figure 9-36.—Upper portion of completed control tower.

"anchor angles" and base plates, set in a concrete foundation.

TANKS

Essential liquids such as water, diesel oil, and gasoline are stored in prefabricated tanks made of mild sheet steel, galvanized sheet steel, or wrought iron. A tank is made up of separate pieces of convenient size, which are usually bolted together for later disassembly and removal, but which may be riveted or welded together for permanent installation. A tank for diesel oil usually holds 10,000 barrels (a "barrel" is a unit of liquid measure equal to 42 gallons). Steel water tanks come in 100-, 500-, and 1,000-barrel sizes.

Figure 9-37 shows the shape of the pieces in two different tank bottoms. In each of these, the pieces which have the same numbers are interchangeable. The sides of a metal tank are made up of curved pieces called staves, each usually about 5 feet wide by 8 feet high.

PONTOONS

When the U.S. entered World War II, our Navy was faced for the first time with the problem of landing and supplying large forces where conventional harbor facilities were occupied by the enemy. Navy Lightered (N.L.) pontoons, designed for erection by Navy personnel and for shipment aboard Navy vessels, were developed in 1942 to meet this problem. Such pontoons proved to be of great value and were used in quantity in most theaters of operation during World War II and the Korean conflict.

The old pontoon system, which was used during World War II, is designated as the T-series. This old system has since been replaced by a new pontoon system, designated as the P-SERIES Navy Lightered (N.L.) equipment. P-series pontoons are stronger than the old T-series pontoons, and are better able to withstand the rough treatment to which pontoons necessarily are subjected. In addition, P-series pontoons are easier to fabricate, require fewer parts, and are more quickly assembled than T-series pontoons.

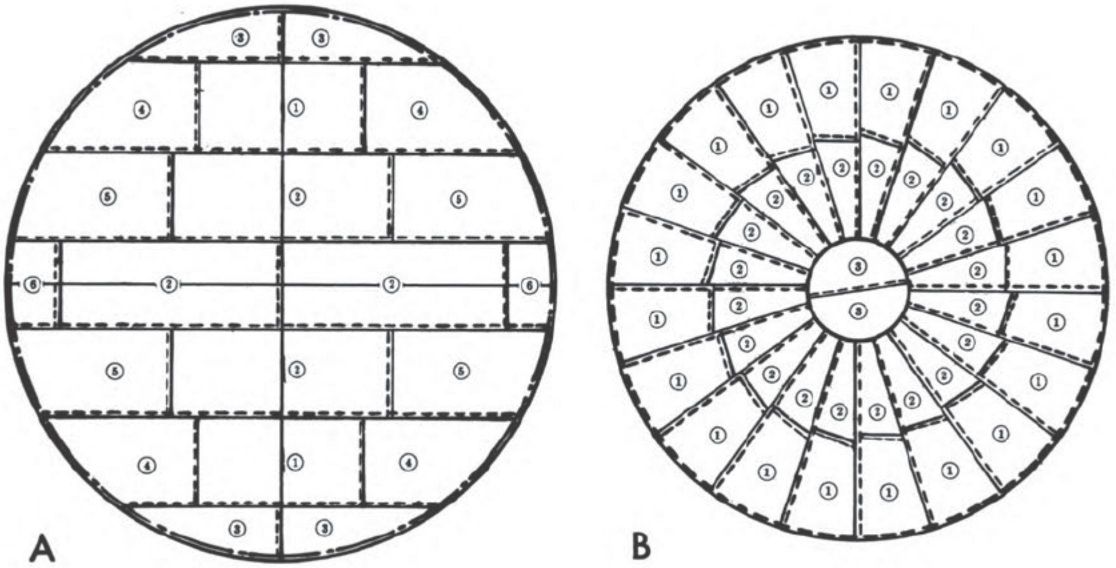
P-series pontoons have been used extensively in the Republic of Vietnam under wartime conditions. Although primarily designed to meet the requirements of the Advanced Base Functional Component (ABFC) Program, they have been used successfully in many other fields owing to their versatility and ease of erection. Large structures were easily and quickly disassembled and made up into smaller structures, and smaller structures were quickly and easily reassembled into larger structures. The light draft, structural strength, mobility, and adaptability of pontoon structures made them highly desirable for shallow-water passage and tactical deployment in the Mekong Delta, where they allowed movement of heavy weapons and shifting of firepower throughout otherwise inaccessible areas. Many structures not discussed in this publication, such as armored barges, helicopter pads, and mortar barges, were constructed in the field for use in special situations throughout the waterways of South Vietnam.

Use of T-series pontoons is being discontinued in the pontoon system. Stocks of all but one type have been depleted, and they will not be replenished.

In recent years a new pontoon, known as the AMMI, has been developed. The Ammi revolutionizes further the number of uses of the pontoon by the Navy as you will see later in this section. The following discussion deals primarily with the P-series and the Ammi pontoons.

P-Series Pontoons

There are five basic types of P-series pontoons, designated P1, P2, P3, P4, and P5. These pontoons are specially designed, internally reinforced, welded steel cubes. They are tested to withstand an internal pressure of 20 pounds per



29.179

Figure 9-37.—Tank bottoms may be composed of various sized pieces which are joined to form a circular shape.

square inch. All pontoons have plain deck plates covered with a nonskid coating, and all are fitted with a 2-inch plugged hole for air, drain, or syphon connections at the top and bottom of one of the end plates.

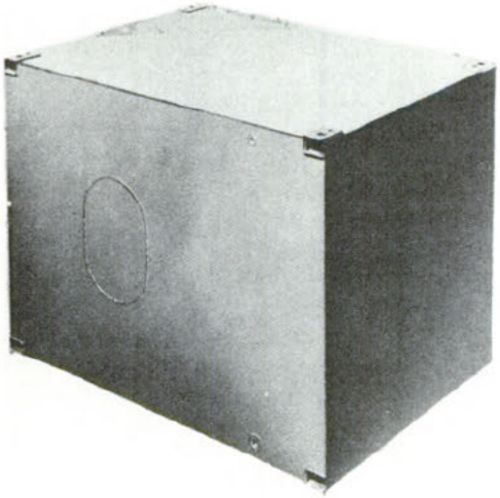
The P1 pontoon is cubicle in shape. (See fig. 9-38.) The deck of the P1 is 5' 3/8'' x 7', and the sides are 5' 3/8'' high. The side, end, deck, and bottom plating is 3/16'' thick. The P1 is the most common and widely used pontoon in the P-series. Its usage is required in every structure of the pontoon system.

The P2 pontoon has the same depth (5' 3/8'') as the P1, but it has a 7' square deck and a straight-line sloping bow. (See fig. 9-39.) The side, end, and deck plates are 3/16'' thick. The sloping bow plate is 3/8'' thick. P2 pontoons are used on the bow and stern of various pontoon structures.

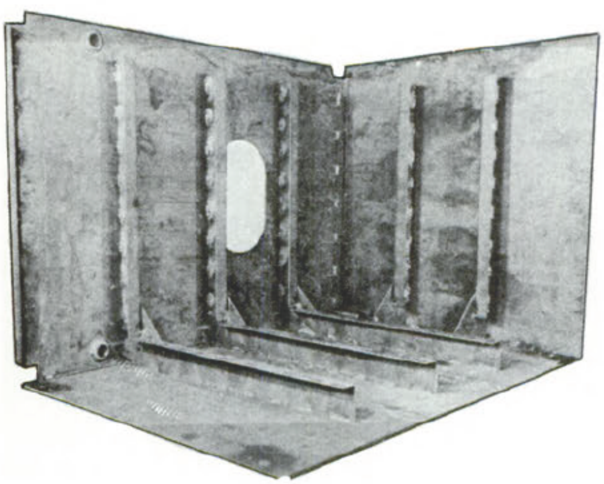
The P3 pontoon has an inclined deck 5' 1-3/4'' long and 7' wide. (See fig. 9-40.) The deck slopes from 4' 11-3/8'' to 3' 8-1/4'' high. The bottom is horizontal. All plating is 3/16'' thick. The sloping deck is fitted with five 1'' square ribs 5' 6'' long, evenly spaced and secured by welding, with a covering of nonskid paint applied between cleats. The P3 is used in conjunction with the P4 to form a gradually sloped ramp for causeway ends and ramp barge bows.

The P4 pontoon has a deck 5' 1-3/4'' long and 7' wide, inclined at the same angle as that of the P3 pontoon. (See fig. 9-41.) The after end is 3' 6'' high; the forward end, 1'. The bottom is horizontal for 8'' on the after end, then slopes upward. The deck, side, and back plates are 3/16'' thick; the bottom or bilge plate is 3/8'' thick. Five evenly spaced, 1'' square ribs are welded to the sloped deck, and a coat of nonskid paint is applied between cleats. Used in conjunction with the P3 pontoon, the P4 forms a continuous ramp for causeway ends and ramp barge bows.

P5 pontoons consist of P2 pontoons with quick-lock hinge connectors fixed to the bow. The P5M is a P5 with a male connector; the P5F is a P5 with a female connector. (See fig. 9-42.) P-series 3 x 15 pontoon causeways are connected end-to-end by alternate P5M and P5F pontoons; so are barge sections that are used as wharves where end-to-end connection is required. These pontoons are constructed by welding hinge connectors to P2 pontoons that are then assembled in male and female sequence, forming causeways of any required length. These pontoons are also used for enlarging or extending wharf structures. The center section of the P5F hinge is made from a section of 8-inch extra strong pipe. The center section of the P5M hinge is made from a reinforced 6-inch extra strong pipe.

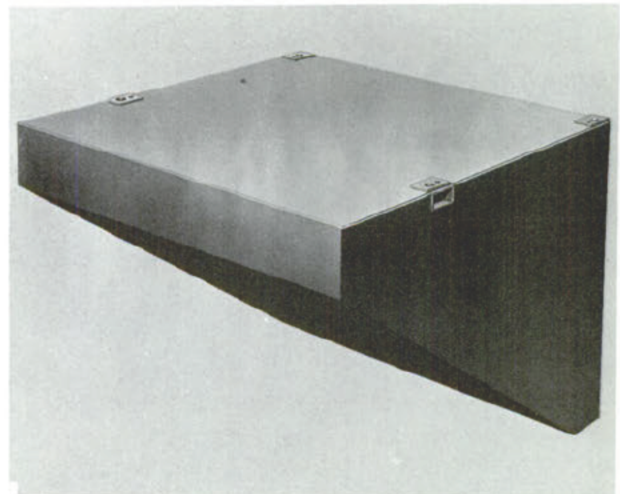


OUTSIDE VIEW

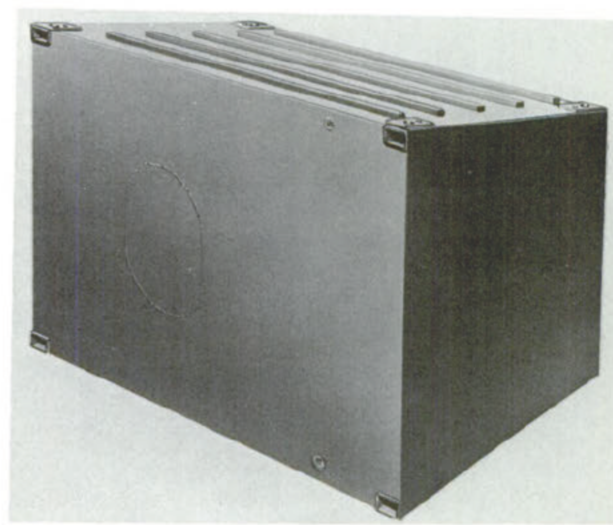


PARTIAL INTERIOR VIEW

29.180.1;.1A
Figure 9-38. — P1 pontoon.



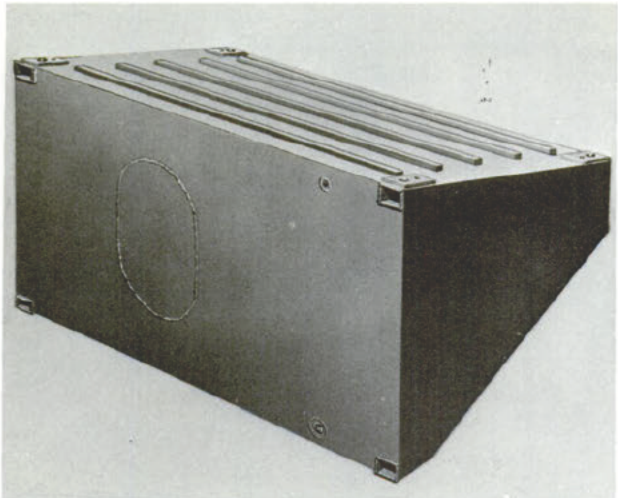
29.180.2
Figure 9 39. — P2 straight-line sloping bow pontoon.



29.180.3
Figure 9-40. — P3 sloped-decked pontoon.

When joined, these two parts resist the torsion, compression, and vertical shear forces in the joint.

Making end-to-end connections with P5M and P5F pontoons is not a difficult task (see fig. 9-42). When the mating ends of two causeway or wharf sections are brought together, the male pipe connection is simply guided into the female and held in place by padeyes and links. The resulting pipe joint then prevents vertical movement of either section. A short chain-locking device completes the connection and secures the links in the padeyes. Each set of hinges is capable of

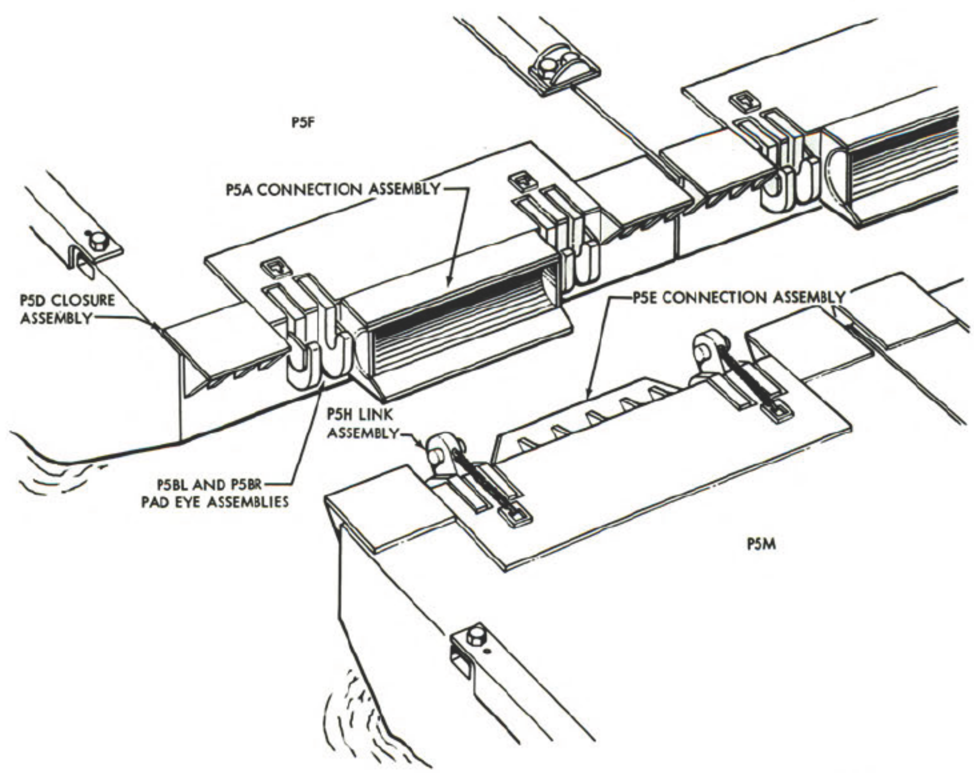


29.180.4
Figure 9-41.— P4 ramp-end pontoon.

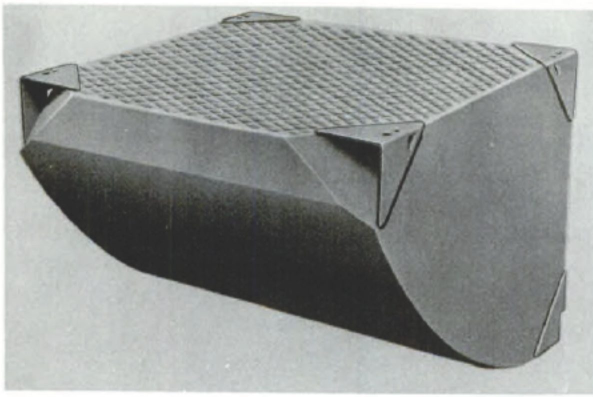
withstanding 300,000 pounds of pull. Closure plates are welded on either side of each connection to bridge open spaces between pontoons.

At some activities you may find that the P-series system makes use of the T7A pontoon. (See fig. 9-43.) It has been found that, with slight alterations, the T7A, which is part of the old T-series system, may be used in place of the P2 straight-line sloping bow pontoon. Modified T7A pontoons will be used in P-series structures until stocks of the old T7A are depleted.

A wide variety of structures—wharves, barges, causeways, and so on—can be assembled from pontoons. In the assembly of pontoon structures, the pontoons are first joined into strings and the strings are launched; the floating strings are then attached to each other. Structures of not over three strings in width may be entirely assembled on land and then launched as a unit. The number of pontoons in each string and the number of strings attached to each other depends upon the size and type of structure being assem-



58.131
Figure 9-42.— End-to-end connections for P5M and P5F pontoons.



29.180-T7A
Figure 9-43. — T7A curved-bilge pontoon.

bled. The manner of assembly is similar in each case, with variations depending largely on the intended usage of the completed structure. The size of each pontoon structure is designated by indicating the number of strings in the assembly and the number of pontoons in each string. Thus, a 3 x 15 causeway section is three strings wide and fifteen pontoons long. Pontoon gear is usually shipped with the parts required to complete a specific structure.

Pontoons are provided with different connecting devices and attachments; these include assembly angles, bolts, nuts, assembly plates, closures and railings. Other attachments that are not standard accessories of the pontoon assembly may be manufactured by SEABEES— using SEABEE ingenuity.

Ammi Pontoons

Another type of pontoon with which the Steelworker may work is the AMMI PONTOON. It is called Ammi to honor Dr. A. Amirikian, the NAVFAC engineer who designed and developed it. While the pontoons which we discussed earlier come in the form of steel boxes, the Ammi pontoon comes in separate panels and segments. These different panels and segments are marked as indicated and packed into bundles that are easily handled by cranes or rough-terrain fork lifts. They are transported to the construction site, then unpacked and assembled by simply following the directions given in the Ammi Pontoon Field Assembly Procedures booklet which is provided with the shipment.

The Ammi pontoon may be assembled to form a variety of structures or objects to suit a predetermined purpose; for example, scows, barges, temporary wharves, causeways, and the like may be fabricated by combining the different panels and segments. It is interesting to note that, very recently, a portable floating drydock made out of Ammi pontoons was successfully tested by Davisville SEABEES. This floating drydock can be assembled or towed to any ocean of the world to receive appropriate size ships for repairs. By use of water ballast and pumps the drydock may be submerged or floated. It is submerged to receive the ship, then floated, if necessary, to enable workmen to make repairs on hulls of Navy ships.

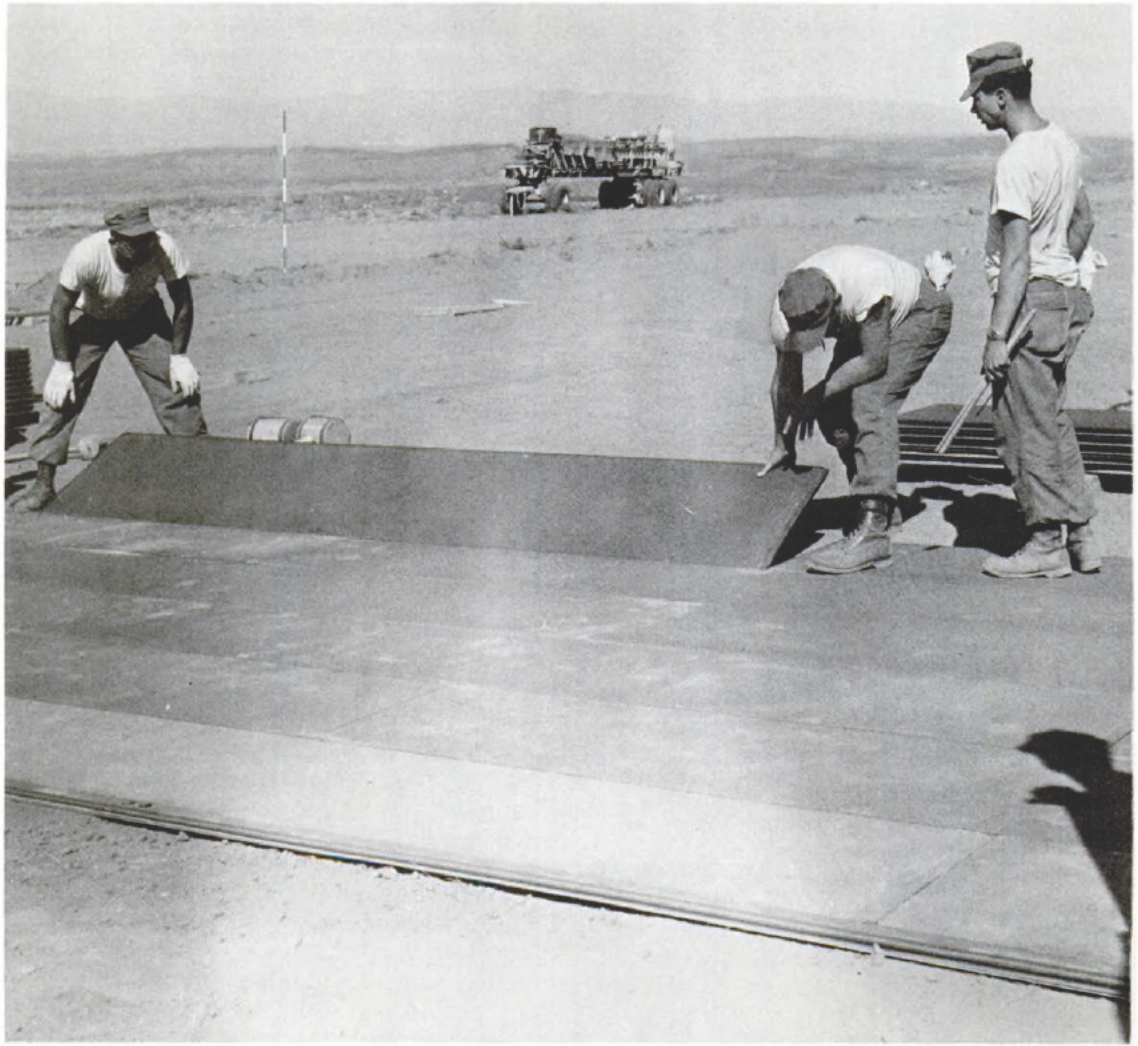
AIRFIELD METAL MATTING

Another interesting phase of the Steelworker's job involves the installation of airfield matting or mats for airfield surfaces (see fig. 9-44). The mats are prefabricated aluminum or steel panels that can be used to form continuous surfaces of any desired length and width. These mats provide a suitable surface for runways, as well as non-runway areas such as taxiways and hardstands.

Lack of time, lack of materials, or other factors may often require the use of these mats for expediently prepared airfields. If the need arises for quick construction of an all-weather runway, for instance, metal matting can be laid on a hastily prepared site to give temporary service until a more adequate runway can be built. Airfield metal matting also may be used to provide a surface suitable for continuous operation of aircraft where bituminous or concrete paving materials and equipment are not available; in these cases the mats are laid on a well prepared site. The base for the matting is stabilized as though it were intended for a bituminous or concrete pavement. When a metal-surfaced airfield is no longer needed, the mats can be dismantled and reused at another location.

There is a special name for an expediently installed airfield made of metal matting. It is called SATS, meaning "Short Airfield for Tactical Support." This is the type of airfield that a SEABEE detachment is usually assigned to install — generally, on short notice and a very limited time being given to accomplish the task.

Various types of metal matting have been developed over the years since World War II. Due to improvements, some types of matting are obsolete and are being replaced by new types.

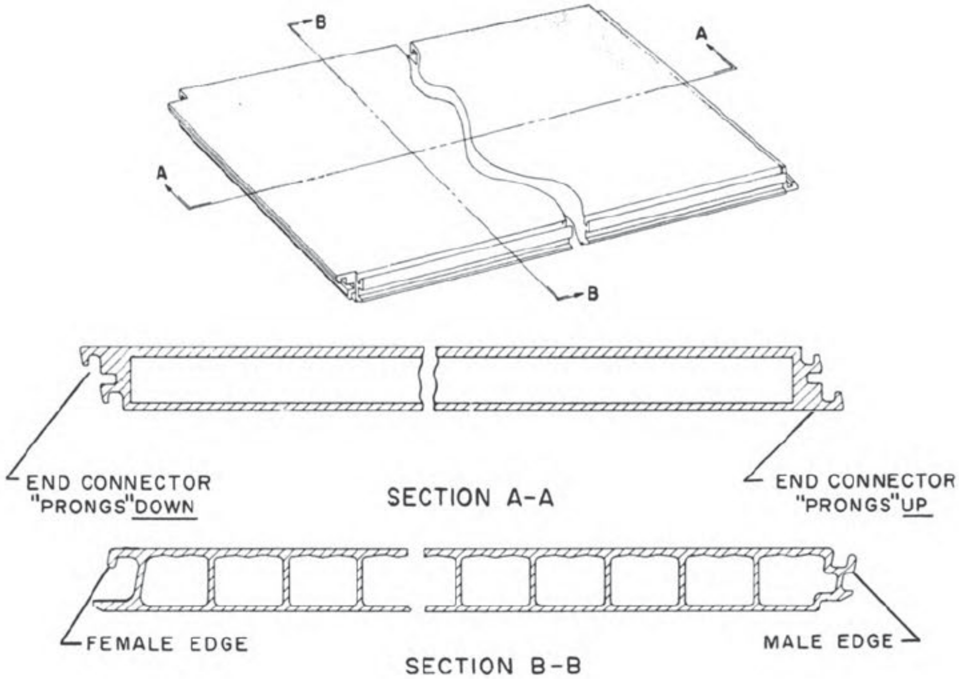


127.106
Figure 9-44.—Placing airfield matting.

As with pontoons, metal matting is designated by letters and numbers. The latest version of a certain type is recognized by a number on the extreme right of the type designation; for example, AM2 is a newer version of AMI.

The AMI type of matting has been installed extensively in various places in South Vietnam. At present, however, it is being replaced by the AM2 type (see fig. 9-45). The AM2, a fabricated aluminum panel, is 1-1/2 inches thick. It consists of a hollow, extruded one-piece main section with extruded end connectors welded to each end. (AM-2 mats may also be fabricated in two- and three-piece main panel extrusions which, when welded longitudinally, form the same size and shape as the one-piece extrusion.)

The sides of the mat panels are constructed on interlock with a rotating motion. The end connectors are arranged with the prongs up to one end and down on the other (fig. 9-45). Thus, by properly placing the end connector of one mat over the end connector of the previous mat, a continuous layer of matting is formed. A flat locking bar is then inserted into the slot common to the two mats to form a non-separable joint.



127.207
Figure 9-45. — AM-2 mat configuration.

As a Constructionman, you may be required to assist in the installation of these mats. You will find that the installation of metal mats is not difficult if their alignment is observed closely and the edges are properly matched at the very beginning of the work. You will be under the supervision of an experienced petty officer; however, you must observe normal safety procedures followed when handling steel materials. Wearing of gloves and safety shoes is a must for this type of work. Employ only the correct tools and equipment in order not to damage the mats.

CHAPTER 10

UTILITIES

Utilitiesmen perform a wide range of duties that involve the installation, maintenance, and repair of heating, water distribtuion, and water treatment systems; air conditioning and refrigeration equipment; and sewage disposal facilities. They must be able to operate and service steam boilers, as well as any machinery relating to the facilities mentioned.

In the area of plumbing, Utilitiesmen install the piping, fixtures, and facilities needed to provide fuel, air, and water, and to dispose of waste. As specialists in air conditioning, they not only install, but also maintain and service air-conditioning and refrigeration equipment. They likewise install, maintain, and service water distillation equipment, water purification equipment, compressors, and pumps. UTs may also operate and perform operational maintenance to internal combustion engines.

In connection with utilities the Constructionman again functions as materials handler, helper, and housekeeper. This chapter gives brief descriptions of the principal jobs done by Utilitiesmen, together with mention of the tools and materials commonly used.

MATERIALS

The treatment of the subject of materials here is necessarily brief. Further information may be found in Utilitiesman 3 & 2, NavPers 10656, as revised.

Pipe used for utilities purposes may be made of clay, concrete, plastic, asbestos, or metal.

Pipes used in drainage systems and house sewers are usually made of cast-iron soil pipe. Concrete, asbestos-cement, or plastic pipe are used in sewer systems where special conditions exist to justify their use; these materials are non-metallic and corrosion-resistant. Asbestos-cement and plastic pipe are also light and easy to handle. Clay pipe is vitrified (glazed) and is used for sewerlines that do not run under some type of permanent structure. Steel and wrought-iron pipe are galvanized to prevent rusting and provide protection against corrosion. The pipe most commonly used for water service in buildings is copper or galvanized pipe.

Pipe is usually stored in racks according to size. The pipe should be cleaned internally before storing by blowing out with compressed air, flushing out with water, or by swabbing with rags. This is necessary to remove any sand, dirt, scale or insects which may have accumulated inside during shipment or previous storage. If outside storage is necessary, it should be covered with a tarpaulin. Size in a particular rack space may be indicated by painting the size on a piece of board and securing it to the pipe rack.

All pipes (except copper tubing) are sized by INSIDE DIAMETER and type of material used. Copper tubing is sized by OUTSIDE DIAMETER and comes in 50- to 100-ft soft-tempered coils, or 20-ft hard-drawn (rigid) lengths. Three types commonly used are type k, l, and m. Type "k" is used for underground service and general plumbing purposes; type "l" for general plumbing purposes; and type "m" with soldered fittings only. Type "m" comes in straight 20-ft lengths, hard-drawn only.

Insulation is used to protect piping and tubing from outside temperatures. It prevents loss of heat of whatever liquid is being conveyed. Insulation also protects personnel against burns from hot piping systems. One of the most used types of insulation is 85-percent magnesium. It comes in three different forms: molded, powdered, and blocked; each is designed for a different purpose. The MOLDED type comes in 3-ft lengths and is used on pipes ranging in size from 1/2 inch to 12 inches in diameter. The BLOCK type is suitable for boilers or other places where you have a large flat surface to cover. It is available in various sized blocks. The POWDERED type, when mixed with water to form a paste, is used as a covering for fittings, valves, and the like. After the insulation is in place, canvas, tar paper,

or metal lagging is used to protect the insulation from the weather and against bumping and crushing. This in turn prolongs the life and quality of the insulation.

Different types of iron pipe fittings are shown in figure 10-1. The term IRON PIPE is a general term which is applied to wrought-iron, steel, and galvanized pipe. As you see in figure 10-1, the upper portion shows actual photographs of some of the fittings, and the lower portion shows the drawing of some of the fittings, and with their openings lettered (in alphabetical order) to indicate the proper sequence of describing the size of the fitting. For example, to describe the size of the reducing elbow, you will write first the size of the larger opening indicated by A, followed by the smaller opening indicated by B, and the type—i.e., 3/4" x 1/2", G.I. pipe reducer.

Fittings are used for making turns, branch connections, continuations, changes in direction, or termination of a line. By merely looking at the different fittings shown in figure 10-1, one could easily figure out the use of each fitting; however, a few will be described here.

COUPLINGS are used to extend lengths of pipes of the same or different size. There are three common types of couplings: straight, reducer, and eccentric reducer. The STRAIGHT COUPLING is used for joining two lengths of pipe in a straight run where additional fittings are not required. A REDUCER is used to join two pipes of different sizes. The ECCENTRIC REDUCER has two female threads of different sizes with different centers so that, when joined, the two pieces of pipe will not be in line with each other, but can be installed so as to provide optimum drainage of the line.

A NIPPLE is a short length of pipe with a male thread on each end. It is used to make an extension from one fitting to another. Nipples come in many precut sizes and are often used in great quantities in plumbing work.

A UNION is used to join pipes coming from opposite directions and is so designed that the pipes can easily be disconnected. The most common types of union are the ground joint (shown in fig. 10-1) and the flange union (not shown). The flange union differs from the ground joint in that it consists of only two parts.

A BUSHING is a fitting having both external and internal threads (male and female). It is most commonly used along with another fitting for a decrease in pipe size.

PLUGS are fittings with male threads. They are used to close openings in other fittings. A CAP is a fitting with a female thread. It is used for the same purpose as a plug except that the cap fits on the male end of a pipe or nipple.

The fittings shown in the lower part of figure 10-1 are generally used for changing direction of a line. ELBOWS change pipeline direction in the amount of 22 1/2°, 45°, and 90°; TEE fittings provide for the connection of a branch; a CROSS provides for two intersecting lines, and so on.

Fittings for copper pipe are similar to those used for iron pipes. However, copper pipes are usually joined by soldering rather than threading.

PLUMBING

The term "plumbing" is applied generally to the installation of the piping systems and utilities features which provide a supply of water to a building, and likewise provide for the drainage of water-borne waste into a sewage system or other means of disposal.

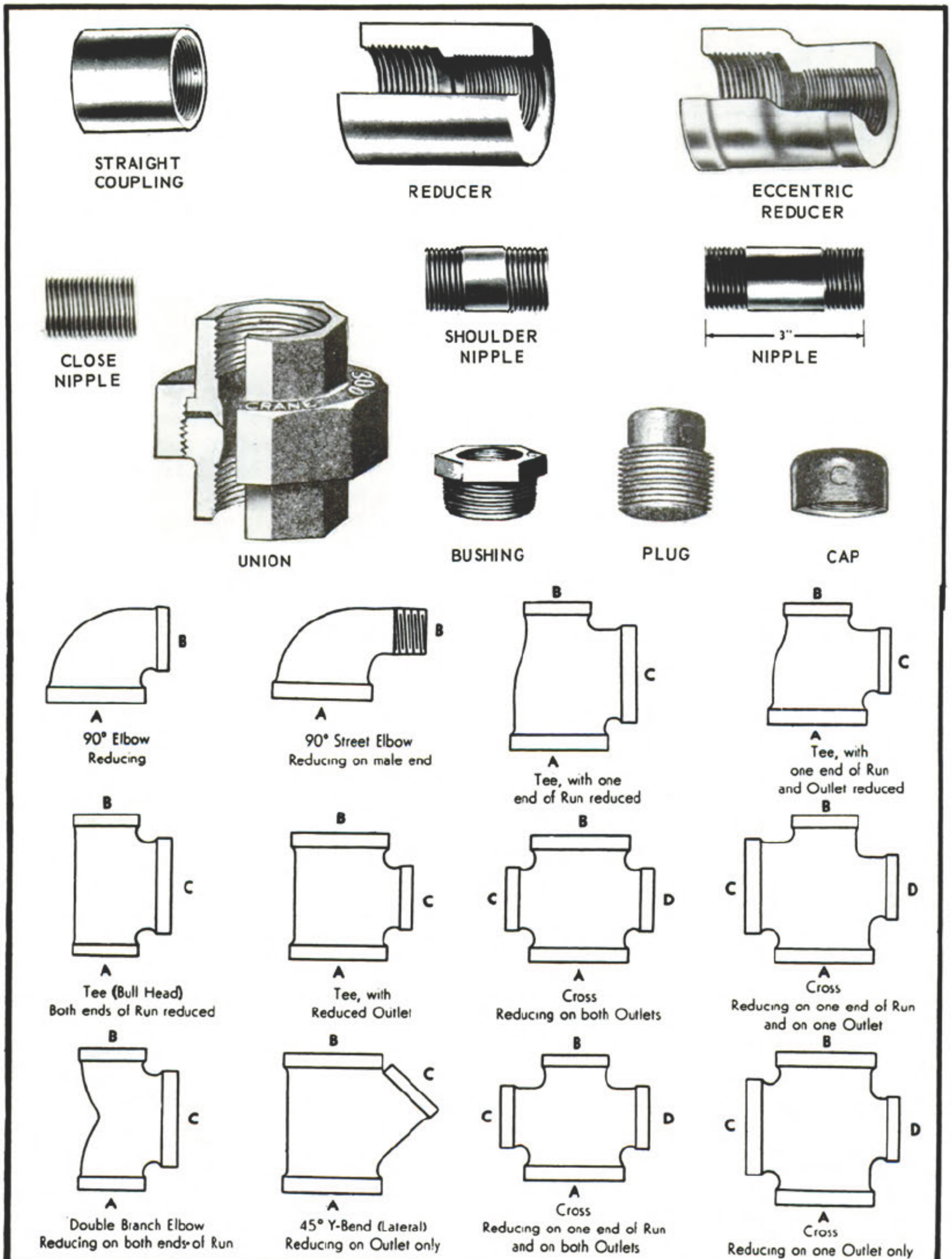
The installation of a piping system involves the measuring, cutting, reaming, threading (if the pipe is to be joined by threading), and joining of the pipe.

MEASURING PIPE FOR CUTTING AND JOINING

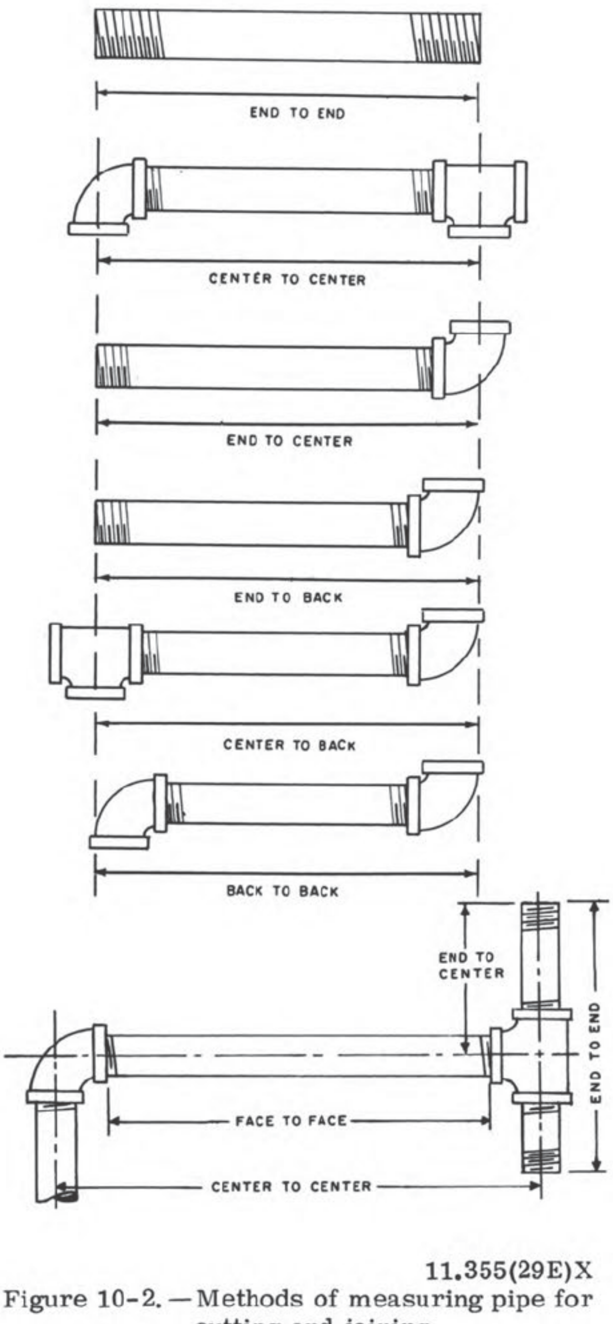
Ability to measure lengths of pipe for cutting and joining is an essential part of a UT's work. Will the pipe fit into the designated space? Is the roughed-in system going to match the intended fixtures that were set and spaced according to standard specifications? What types of fittings should be used? These are only a few of the things that a UT must consider before he starts measuring and cutting.

A rule or steel tape is used to measure lengths of pipes. A UT must be able to read closely the graduations of the particular tape he is using. Several methods of measuring pipes for cutting and joining are illustrated in figure 10-2. Again, by merely studying the different illustrations in figure 10-2, one could go along and take measurements of a pipe and fittings which will fit a certain space; however, the measurements indicated in the figure are explained below.

END TO END indicates a pipe that is threaded on both ends. The measurement is from one end of the pipe to the other end, including both threads.



11.310:.311(29E)
Figure 10-1.—Iron pipe fittings.



11.355(29E)X
Figure 10-2.—Methods of measuring pipe for cutting and joining.

CENTER TO CENTER means that there is a fitting on each end of the pipe and the measurement is made from the center of the fitting on one end to the center of the fitting on the other end.

The END TO CENTER method applies to pipe having a fitting on one end. The measurement is made from the end of the pipe to the center of the fitting.

END TO BACK also refers to pipe with a fitting on one end only. But the measurement here is from the back of the fitting to the other end of the pipe.

CENTER TO BACK indicates a pipe with a fitting on each end. The measurement, in this case, is taken from the center of one fitting to the back of the other fitting.

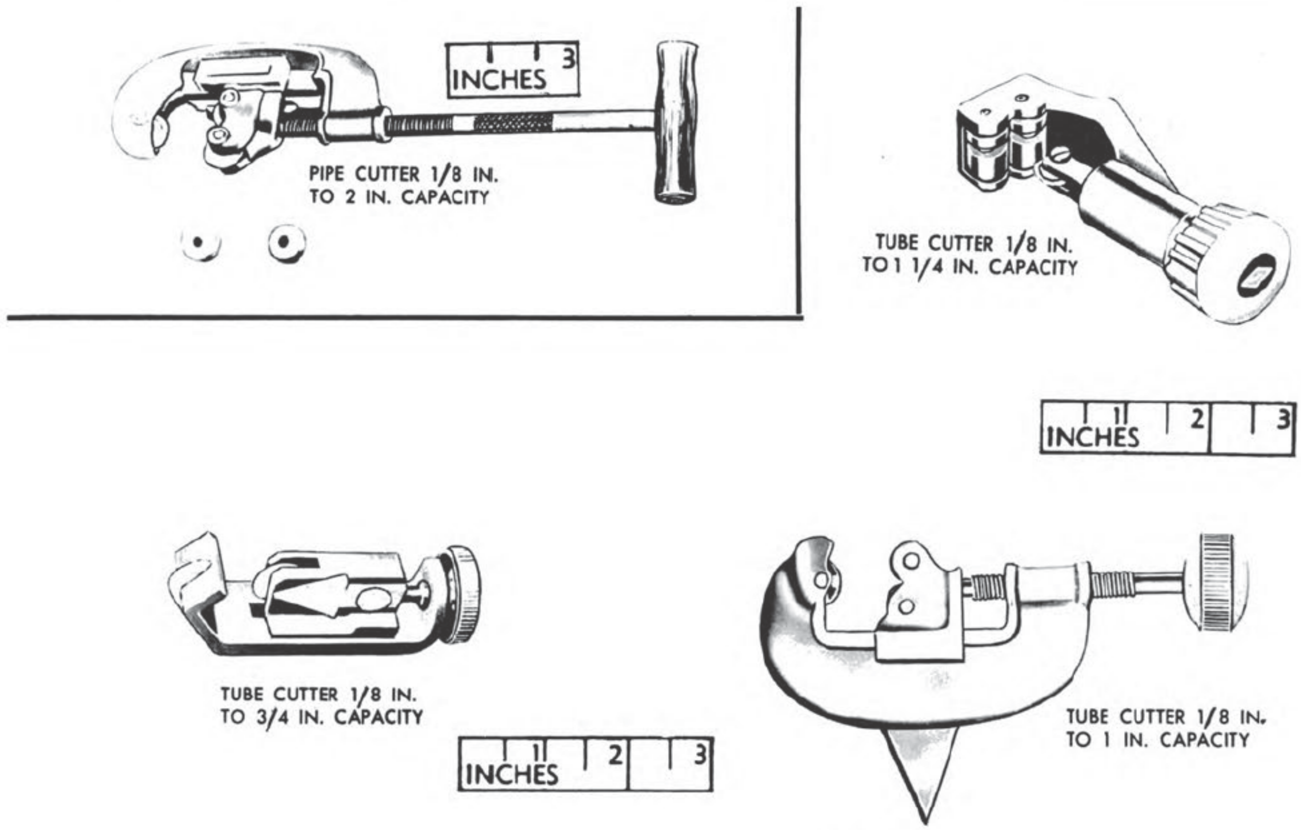
A BACK TO BACK measurement refers to pipe with a fitting on each end. Here the measurement is from the back of one fitting to the back of the other fitting.

The bottom illustration of figure 10-2 shows a portion of an assembled plumbing system and indicates where different measurements are made.

CUTTING PIPE

The technique of cutting pipe is another requirement that a UT must learn thoroughly. He must select the most efficient tool available for cutting a pipe of certain size and type of material. Cast-iron soil pipe, for example, may be cut by using a hammer and a chisel, or by using a special cast-iron soil pipe cutter generally referred to as a snap-cutter. Clay and concrete pipes can be cut with a hammer and chisel or by using a mason's hammer. Asbestos cement pipe is cut by using a special cutting tool or a power saw. In cutting these pipes, you must measure the correct length and scribe a cutting line around the pipe at the desired length. Select a chisel with a blunt cutting edge ane a hammer. First, make a light cut mark with the chisel and hammer all the way around the pipe—using light hammer blows. Continue around, deepening the cut slightly each time, until the pipe wall is broken through along the cutting line. The pipe should be supported at the cutting line solidly by sand or a piece of wood.

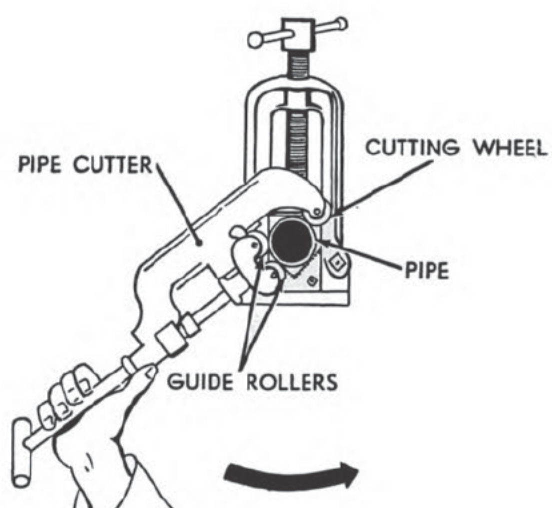
Steel, wrought iron, brass, and copper pipe (and copper tubing) up to 4 1/2 inches in diameter are cut with cutters similar to those shown in figure 10-3. These cutters come in various size capacities to suit different metal pipe and metal tube cutting needs. The WHEEL-AND-ROLL



44.36
Figure 10-3. — Pipe and tubing cutters.

CUTTER shown in the upper left view of figure 10-3 is commonly used for cutting pipe and tubing. In figure 10-4 the wheel-and-roll cutter is being used to cut pipe being held by an angle-jawed PIPE VISE. The wheel-and-roll cutter contains a single cutting wheel and two rollers. A THREE-WHEEL CUTTER is similar in construction, except that instead of rollers, it has cutting wheels — that is, it has three cutting wheels and no rollers. The three-wheel cutter is generally used when a complete 360° turn cannot be made. A wheel-and-roll cutter may be converted into a three-wheel cutter, by simply removing the rollers and substituting a pair of cutting wheels like those shown in the upper left view of figure 10-3.

When using the wheel-and-roll cutter, slide the cutter onto the pipe, set the wheel at the cutoff mark, and tighten the handle so as to force the wheel a little ways into the pipe. DON'T apply too much pressure for it will dull the cutters and may crush the pipe or tubing walls.



29.205
Figure 10-4. — Wheel-and-roll pipe cutter.

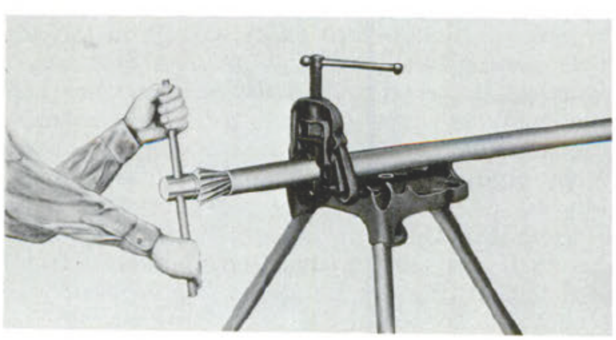
Rotate the cutter completely around the pipe, and turn the handle one-quarter turn for every revolution. Repeat this procedure until the pipe is cut through.

An advantage of the three-wheel cutter is that one-half revolution of the cutter makes a cut all the way around the pipe. The three-wheel cutter, then, is valuable in a situation where you can't get a complete swing-around with the cutter. What you do here is set up the jaws, rotate half-way around in one direction, then set up a quarter-turn and rotate half-way around in the opposite direction.

In the absence of a wheel cutter, you can cut metal pipe with a hacksaw or a cutting torch. When cutting a pipe, be careful to cut it exactly at a right angle, especially if the pipe is to be threaded. If the cut is uneven and not at a right angle, the threads will probably not fit the fittings—for these reasons, a cutting torch is not recommended for cutting pipes to be threaded. Besides, the intense heat of the cutting torch would weaken or soften the piping material.

REAMING PIPE

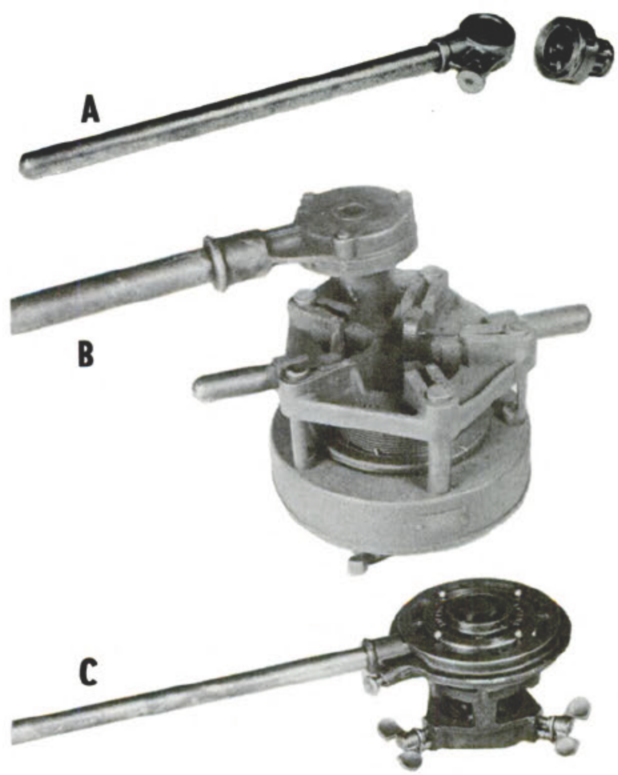
When a pipe is cut, burrs are left on the cut end. If the burrs inside the pipe are not removed, they may restrict the flow through the pipe, and likewise may choke the line by causing an accumulation of solid material which would otherwise pass on through. The burrs can easily be removed by reaming, as shown in figure 10-5. A hand-operated spiral-type reamer is recommended for reaming. Burrs on the outside end of the pipe are removed by filing.



29.206
Figure 10-5.—Reaming a cut-off pipe.

THREADING PIPE

Pipe may be threaded by hand or with a machine. Three types of hand-operated dies are shown in figure 10-6. View A shows a ratchet-type threader in which dies of different sizes can be inserted in the ratchet stock. The threads in the die are slightly tapered; this makes starting the die on the pipe end relatively easy. Set the die on the pipe end, making sure that the die forms a right angle with the pipe. Then press the die against the pipe end with one hand and turn the ratchet stock with the other. After the die has engaged for a thread or two, it will "feed" itself along without pressure. This type of die is used for pipe from 1/8 through 2 inches in diameter. View B shows a "geared" threader with a ratchet handle, so called because it contains a gear system which provides a mechanical advantage. The geared threader is designed for threading larger sizes of pipe (2 1/2 through 6 inches). View C shows another ratchet type



29.207
Figure 10-6—Three types of pipe-threading dies.

threader with interchangeable dies, which is used for threading pipe up through 2 inches.

To begin cutting with the types shown in views B and C, place the die-stock on the pipe so that the pipe passes through the guide and enters the tapered face of the die, forming a right angle with the axis of the pipe. Then tighten the guide bolts, making sure the pipe is centered. The dies are fed onto the pipe by the threaded hub of the die-stock.

For easy threading, use a pumping action when operating the pipe threading dies. The pressure must be applied above and at the handgrip of the handle in order to give maximum efficiency. The ideal position is attained when the hand of the operator is not raised higher than his waist during the pumping stroke. One stroke must cover approximately a quarter-turn on the pipe.

Do not use a dirty die. Always clean out the chips from the die head before threading. If chips are allowed to accumulate, a rugged thread may result which, in turn, may produce a leaky joint.

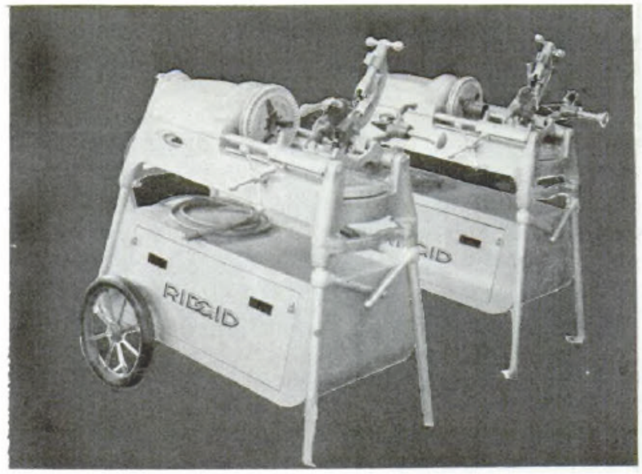
As you cut along, frequently flood the die with a special CUTTING OIL which ensures a smoother and easier cut. This type of oil cools the die cutters. The cooling effect preserves the hardness and hence helps prolong the useful life of the die.

Whenever possible, use only this special cutting oil, because the use of ordinary lubricating oil or plain water may result in rough threads and possibly cause premature wear and tear on the die. Apply the cutting oil every fourth stroke for best results.

When cutting oil is not available, a soapy water may be used as a substitute. Soapy water is better than nothing; it will also help cool the die.

The length of the threaded section depends on the size of the pipe being threaded. Generally speaking, the correct length has been threaded when a thread or two can be seen beyond the die.

On big construction projects you may find power-operated pipe machines. Power-operated pipe machines are big timesavers, especially where a large volume of cutting is to be done, since they are generally supplied with cutter, reamer, and die attachments. One type of an electrically operated pipe machine is shown in figure 10-7. The operation of power-operated pipe machines is the responsibility of an experienced UT; for best results and to know the required safety precautions, he must study the manufacturer's manual of the particular machine



54.52
Figure 10-7.— Electrically operated pipe machine.

concerned and follow the recommendations contained therein. Special training in the proper use and maintenance of these machines may also be attained by on-the-job training.

JOINING PIPE

Joining threaded pipe with fittings appears quite easy, but a threaded joint, like any other, will leak if it is not made correctly. First you must be sure that the threads are clean and not damaged. Check threads by hand-screwing a new (unused) fitting onto the male thread. If the threads are in good condition, you should be able to make three complete turns without much effort. Second, the pipe threads must be coated with a good combination lubricant and sealer—familiarly called PIPE DOPE (usually made of white lead). Do not apply the pipe dope onto the female thread or fitting—this may result in the pipe dope getting into the system. The best way to avoid this is to start the fitting at least one turn, then apply the pipe dope. A sufficient amount of dope must be applied to ensure easy separation of the pipe, if necessary, and besides, the dope acts as a seal for slight irregularities in the threads. Finally, set up the fitting firmly on one pipe-end, and set up the other pipe-end firmly into the fitting by using an appropriate pipe wrench. Make certain that the pipe wrench jaws are clean and locked in place before applying pressure. When a great amount of pressure is needed to tighten the joint, as when tightening the joints of larger pipes, make sure you are in

a balanced position to prevent accidental injury in case the wrench should slip. Never use a "cheater" (extension bar)!

Copper pipe and tubing may be connected by soldering; this type of joint is referred to as a SWEATED JOINT. Tubing is also connected by flared nuts and screw fittings. A flared nut is slipped onto the tubing before the tubing is flared out to a funnel shape at its end by using a special tool. Flaring tools are shown in figure 10-8. A tubing being flared is shown in figure 10-9. Soldering is explained in Basic Handtools, NAVPERS 10085 (revised). Copper has the advantage of bending, in which case the use of an elbow fitting to make a turn can be eliminated. One type of tool used in bending a copper tubing is shown in figure 10-10. Hard tempered tubing is bent with a bender or spring. The tubing is filled with easily removable material such as sand, lead, or rosin to prevent it from collapsing at the bend during the bending process. Be sure to remove all filler material immediately after bending to prevent it from getting into the system.

Cast-iron pipe is commonly called bell-and-spigot pipe, in which a plain "spigot" end on one section fits into a flared "bell" end on the adjacent section. A joint of this kind is sealed by packing it with oakum and sealing with melted lead as shown in figure 10-11.

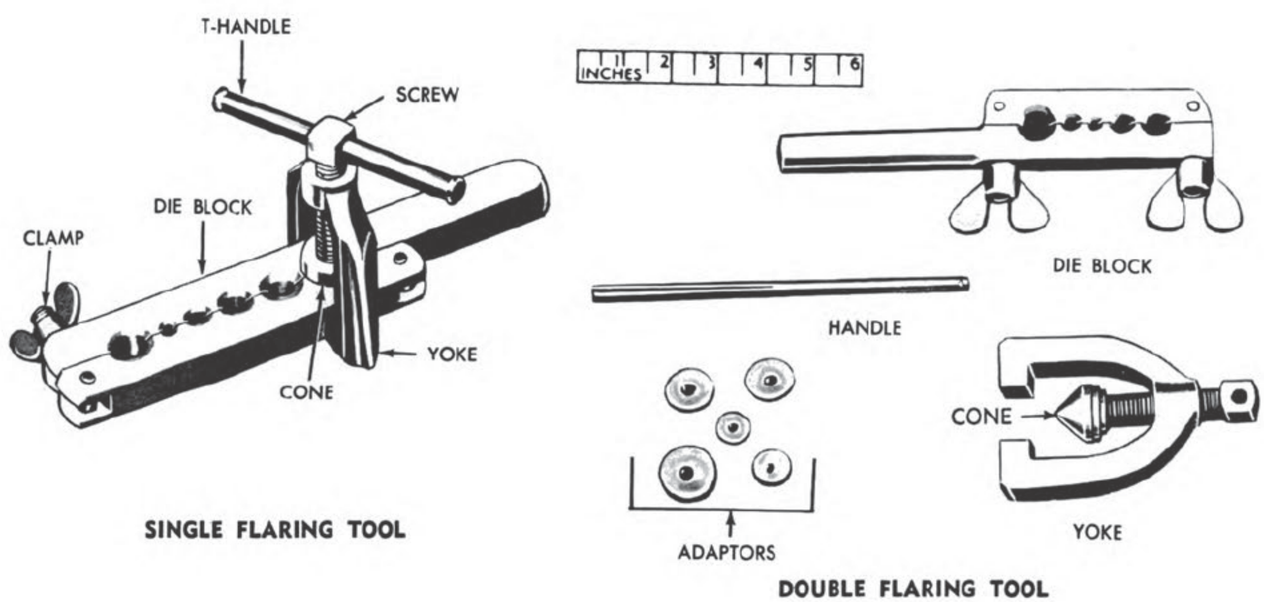
VALVES

The flow of liquid in a plumbing system is controlled by valves. A wide variety of valve designs is available; however, only those valves which are commonly used to control flow in a plumbing system will be described here. The most commonly used valves to control the flow of water in a plumbing system are the GLOBE VALVE and the GATE VALVE.

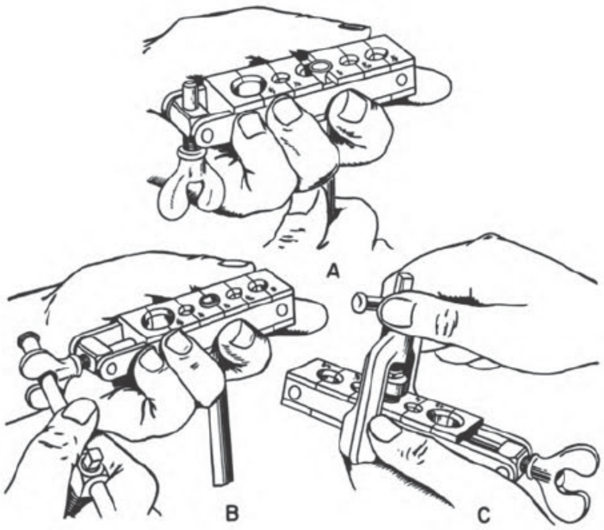
Globe Valves

A cross section of a globe valve is shown in figure 10-12. The valve is shown open in this view. You can see that when it is closed (by turning the handwheel clockwise all the way) the disk is seated solidly in the "body seat ring." This enables the glove valve to cut off a very high-pressure flow, as in a steam line. For this reason, the globe valve is also called a compression valve.

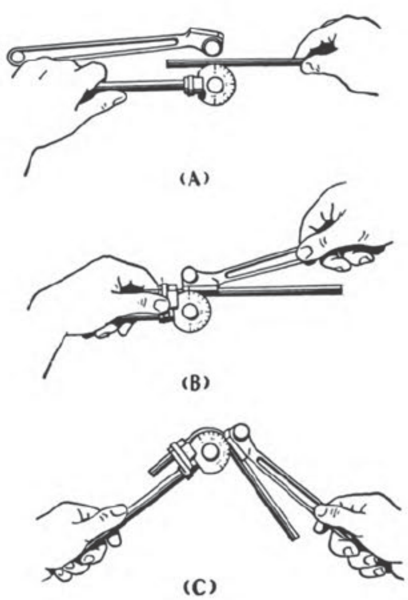
If a globe valve leaks, it is usually because dirt and/or scale on the seat prevents the disk from seating properly. When the valve is closed, the dirt and/or scale tends to score the bearing surfaces of the disk and/or seat. If this damage is severe, disk and seat may have to be replaced. Less severe damage may be repaired



44.37
Figure 10-8. — Flaring tools.



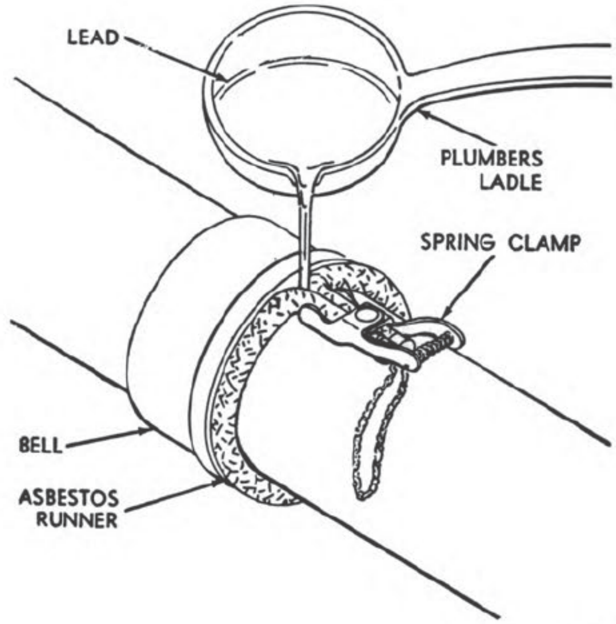
44.186X
Figure 10-9.—Flaring metallic tubing.



11.163
Figure 10-10.—Hand tubing bender.

by turning down in a lathe, or by the use of valve reseating tools.

To disassemble a glove valve for inspection or repair, you remove the bonnet, back off the packing nut, and screw out the stem with disk attached. NEVER use a stillson wrench on the



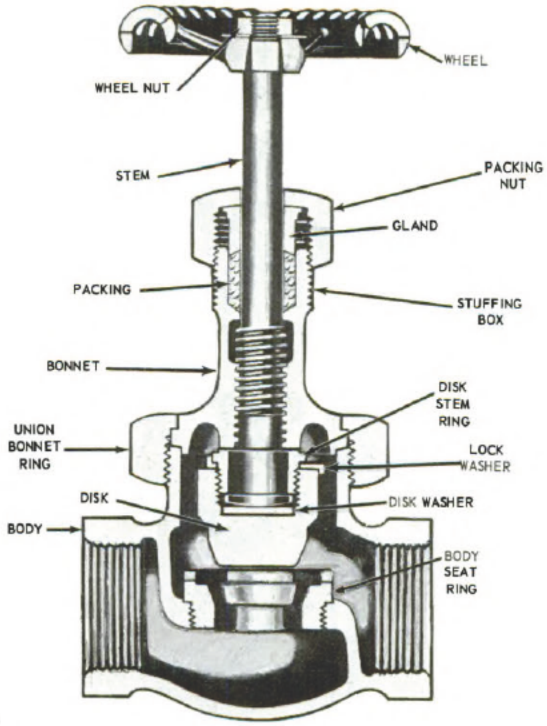
29.208
Figure 10-11.—Pouring lead seal for joint in cast-iron pipe.

hex bonnet ring and packing nut. Use a monkey wrench, because a stillson will chew up these items.

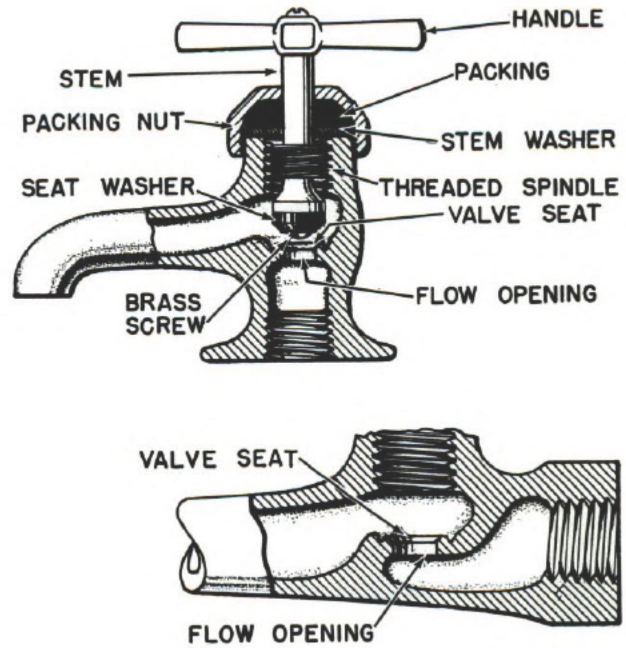
A compression faucet (fig. 10-13) is, technically speaking, a form of globe valve. The faucet (in Navy language a "spigot") is shown open in the figure. You can see that when it is closed the flow of water is stopped by the seat washer, compressed against the valve seat. When one of these spigots leaks, it is most often because the seat washer has deteriorated.

To replace the seat washer, first turn off the water supply to the spigot, and open it all the way. Unscrew the packing nut with a monkey wrench or other adjustable wrench (NOT with a stillson), and unscrew the stem. Remove the small brass screw which holds the washer in place, and replace the washer with a similar one.

When a new washer fails to stop a leak, the trouble is a scored valve seat. The simplest remedy for this is to replace the valve seat with a new one, if this is possible. If not, the valve seat can be refaced with a tool called a reseater. The reseater has a stem and handle like the faucet itself, but has a reaming or dressing device at the lower end. Use it according to the manufacturer's instructions.



11.317.1X
Figure 10-12. — Globe valve.



54.81
Figure 10-13. — Compression faucet.

Gate Valves

Figure 10-14 shows a cross section of a gate valve. The valve is shown open. You can see that when it is closed, the flow through the pipe is prevented by a vertical wedge-shaped disk which closes the opening with a wedging action.

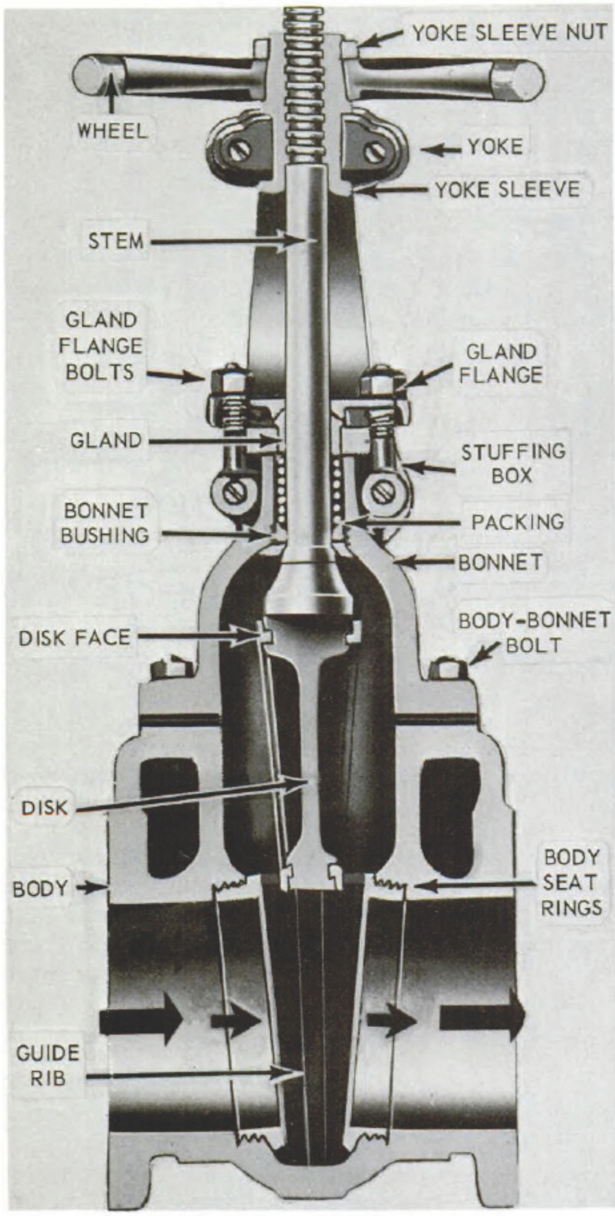
Gate valves are used in low-pressure water lines. They are used to secure flow (not to throttle flow) and are either all open or all closed. The valve which shuts off the water supply to a building is usually a gate valve. Gate valves require very little servicing.

CLEARING STOPPAGES

Many relatively minor stoppages in drains and water closets can be cleared with the "force cup" (familiarly known as the "plumber's friend") shown in figure 10-15. As you work the handle of the cup up and down, the device acts as a vacuum/force pump to force the obstruction out of the drain. The force cup will work only if there is enough water to form a seal around it. Usually, a simple stoppage can be unplugged by use of a force cup.

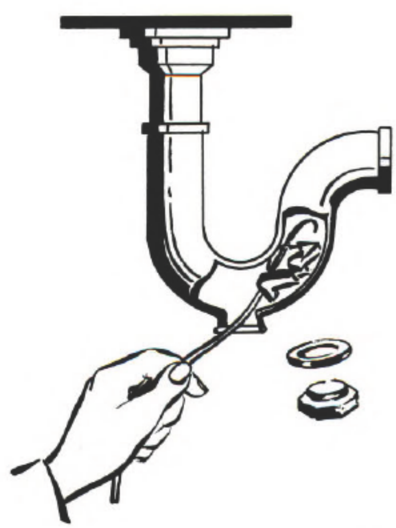
A "trap" is a U-bend in a drain, intended for the purpose of "trapping" water enough to form a seal which will prevent sewer gas and odor from backing up through the drain. Some traps can be opened for cleaning as shown in figure 10-16, when a stubborn obstruction has refused to respond to a force cup.

Various types and sizes of COIL-SPRING AUGERS are available for clearing severe obstructions such as newspapers, rags, garbage, masses of congealed grease, and toilet articles from drains and waste lines. Figure 10-17 shows a coil-spring steel auger, with a corkscrew-type point and a crank-handle, which can be fixed to the auger by tightening a setscrew. When the setscrew is slackened, the auger will pass through the handle. You feed the auger into the drain or pipe until the corkscrew point meets the obstruction; then run the handle up as far as it can go and set the thumbscrew. Turning the crank should then work the point into the obstruction, which can then be drawn out by extracting the auger.



11.317.2X
Figure 10-14.—Gate valve.

29.210
Figure 10-15.—Clearing drain with a force cup.

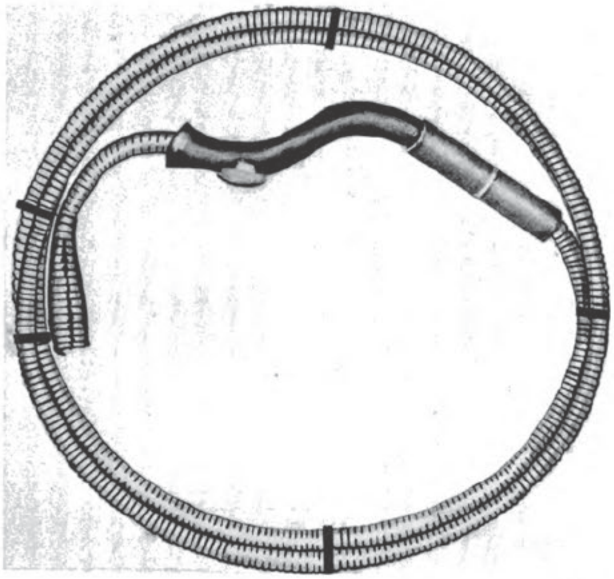


29.211
Figure 10-16.—Cleaning out a trap.

A CLOSET AUGER and its use are shown in figure 10-18. There are also sewer rods of flat steel or wood connecting sections, with revolving spear points, wire sewer brushes, scrapers, and various other devices for clearing obstructions.

TRENCHING FOR PIPELINES

Trenches for pipelines are dug by machines or by hand. If the soil is suitable for machine work, trenching or excavating is generally done



29.212
Figure 10-17.—Coil-spring steel auger for clearing drains.

29.213
Figure 10-18.—Closet auger.

by machines. EOs will operate the machines (ditcher or backhoe) during the excavation. Hand excavation is done by UTs using a pick and shovel. Excavation safety precautions discussed in chapter 6 of this training manual must be followed.

If the flow in the pipeline will be of gravity (no pumps), an important consideration in trenching is to obtain the proper grade or slope. Grade is very important when laying out pipelines for a sewer system. The pipe must be laid at an incline just right so that solids (wastes) borne by the water are carried continuously without interruption. The proper grade of the sewerline will be as specified by the design engineer. It is important that the trench for the sewerline be dug properly and to the desired depth. EAs set the proper grade or depth by using an engineer's level. UTs lay the pipe to conform to specified elevations using the method illustrated in figure 10-19.

LAYING WATER PIPE

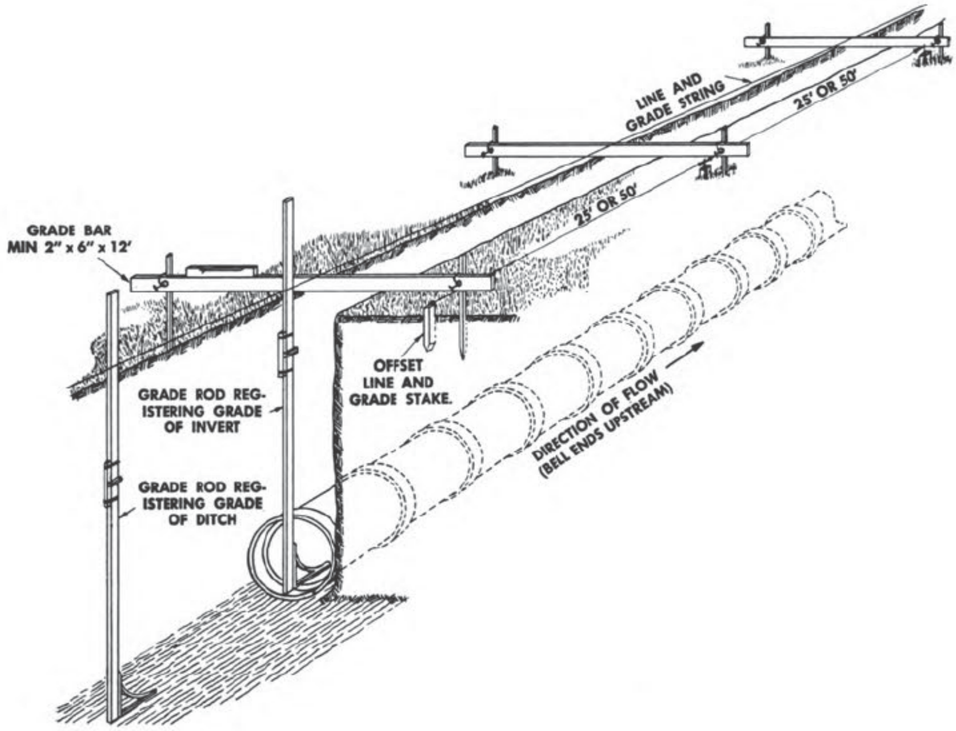
The pipeline which delivers water from tank or reservoir to the buildings in a community such as an advanced base is called the water main. The "head" of water in the tank or reservoir is on a higher level than the service outlets in the buildings, and the flow is therefore a pressure flow—meaning that it does not require a downward slope in the pipe. A water main is usually made of cast-iron pipe. In freezing climates it must be placed below the frost line, which in most freezing areas other then the Arctic and Antarctic lies from 18 to 24 inches below the surface. In most cases, then, pipe must be placed 36" to 48" below the surface. However, pipe laid in areas subject to vehicle traffic must be at least 4 feet below the surface.

Branch service lines, running from the main to the various buildings, are usually of galvanized pipe.

LAYING SEWERLINES

A sewer may be either a storm sewer, for draining off rain-water accumulation, or a sanitary sewer, for draining off waste. Storm sewerlines are usually made of concrete pipe, in sizes running from about 15 inches up to 106 inches or more. Surface drain water is admitted to the line by way of various types of openings called inlets.

A storm sewer flows as a consequence of the downward slope of the pipeline. This slope must



54.23
Figure 10-19.—Laying sewer pipe to line and grade.

be as gradual as possible, to prevent the necessity for eventually having to dig the pipe trench far down into the ground. The amount of drain water to be disposed of at a particular inlet point is the basis on which design engineers determine the size of the pipe and the degree of slope it must have from that accumulation point to the next one.

Inlets are most frequently located at manholes, and pipe trenches are dug from one manhole to the next. Trench depths along the way are established by Engineering Aids from profile drawings based on the design data.

Sanitary sewers also flow as a consequence of the slope in the line. In general, the design problem is much the same as it is with storm sewers, except that it is based on a "peak" accumulation of waste during the hours when the most waste may be expected in the system. A sanitary sewerline is usually made of cast-iron or vitrified clay pipe. For sanitary reasons, it has no open inlets. Manholes or other air-access openings are sealed. The pipe, on the average, is much smaller than storm-sewer pipe.

WATER POINTS

The term WATER POINT is used to designate a source of water which can amply support the daily water consumption requirements of a naval base. This source may be a point at a river, a lake, a spring, a well, or even the ocean (if desalting facilities are available). Usually, however, the water supply for an advanced base comes from wells. A well, as a source of water supply, is both economical and safe; security is not much of a problem, because the well can be sunk in a preselected point inside the base which is considered not vulnerable to enemy infiltration. Only the well, as a water source, will be discussed in this section.

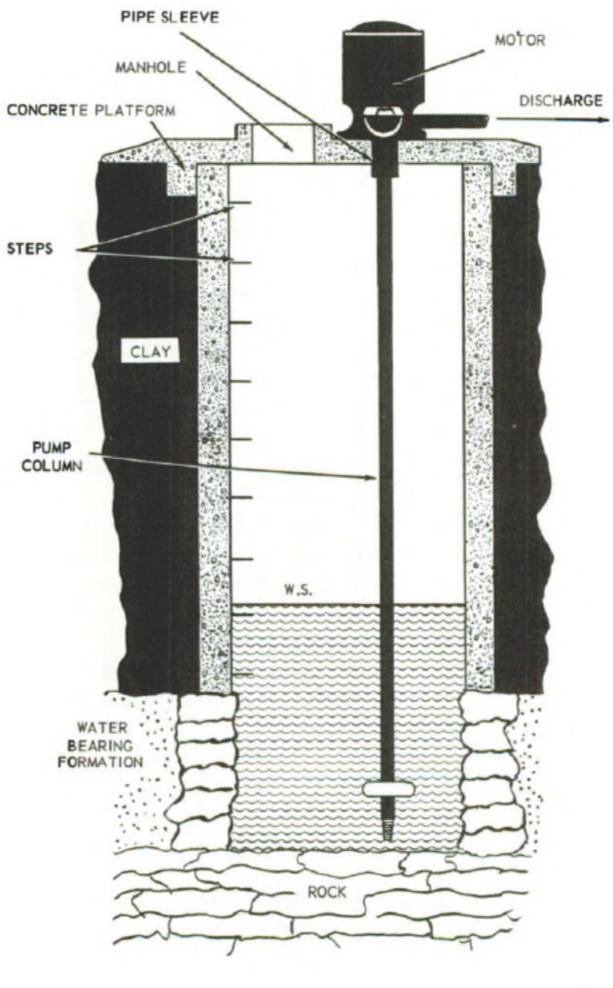
WATER WELLS

The simplest type of well consists merely of a hole, dug down to the below-ground "water table," together with a crank-operated "windlass," a line, and a bucket for hauling water up by the bucketful, or a hand pump for pumping it up by hand.

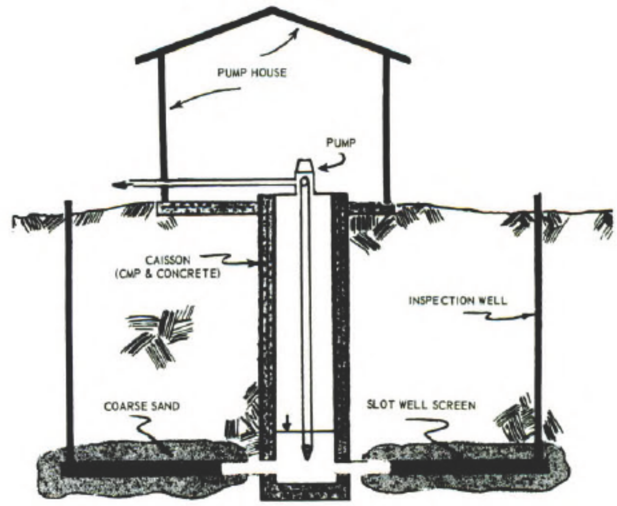
Figure 10-20 shows how a dug well of this type is equipped with a power-driven pump, so that a constant supply of water can be maintained in tanks or other types of reservoirs. The long shaft below the pump is called a well point. Instead of being dug, the hole for the well point might be bored, drilled, or jetted out. In a "driven" well the well point is simply driven down to the water table.

If a well is located near the ocean, salt water infiltration may become a problem. To prevent a rapid pump down which may cause intrusion of salt water, horizontal well screens are constructed as shown in figure 10-21.

When the water demand is great, a series of wells, called a MULTIPLE-WELL INSTALLATION, is usually constructed. These wells are



29.326
Figure 10-20. — Dug well equipped with pump.



29.424
Figure 10-21. — A well with a screen to prevent infiltration of salt water.

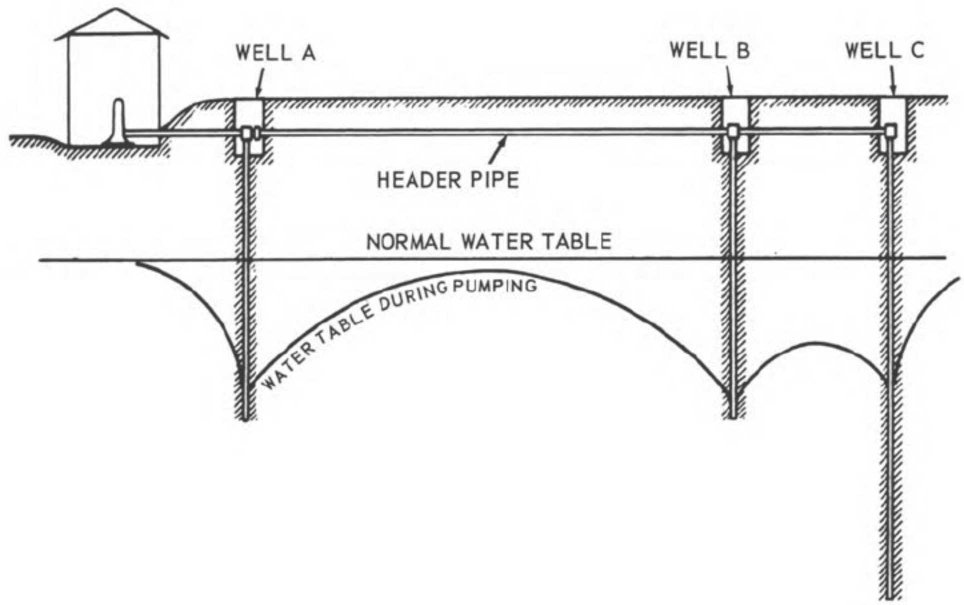
piped together and connected to the pump as shown in figure 10-22. As you can see, each of the well points feeds into a common pipe called a HEADER pipe.

PUMPS

The use of pumps in a well-water supply system was mentioned in the previous section. Pumps are also used in the Navy for such purposes as pumping water out of flooded excavations, raising drain water from a lower to a higher level in a drainage system when the downward slope of the pipeline cannot be continued, and pumping liquid fuel through fuel pipelines. Several common types of pumps may be briefly described as follows.

Reciprocating Pumps

A reciprocating pump works on the vacuum principle. Its name is derived from the back-and-forth, or up-and-down motion of a piston or plunger in the liquid end of the pump. The construction of one type of reciprocating pump, the single-acting type, is shown in figure 10-23. The piston in a reciprocating pump reciprocates in a cylinder in the same manner as the pistons move in a diesel or gasoline engine. Pumping is accomplished through displacement of the liquid by the piston as it moves through the pump



29.327
Figure 10-22.—Multiple-well installation.

cylinder. The basic pump mechanism can be described as a piston which sucks in the liquid on one stroke (INTAKE) and then discharges or pushes out the liquid on the RETURN or RECIPROCATING stroke.

A pump which could also be classified as a "reciprocating pump" (strictly speaking) is the DIAPHRAGM PUMP (fig. 10-24). The essential difference between the diaphragm pump and the reciprocating pump described above is that the diaphragm pump employs a flexible diaphragm instead of a piston or plunger to move the liquid.

A UT may have occasion to use the diaphragm pump for such duties as dewatering trenches where sewer or waterlines are to be laid, or when repairing breaks in water or sewage lines.

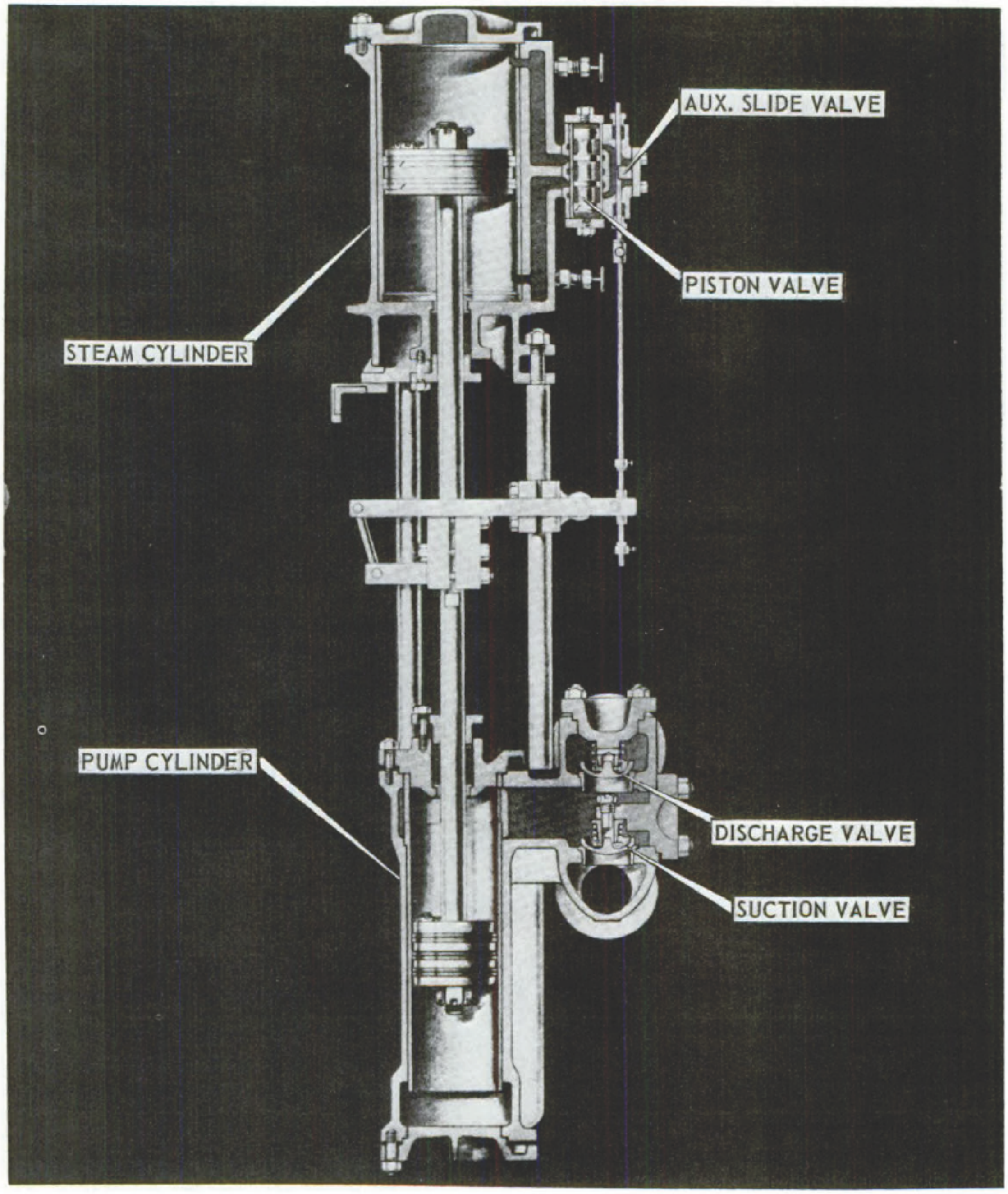
Two of the most popular types of diaphragm pumps are the mud hog (closed discharge) and the water hog (open discharge). The MUD HOG is suitable for jobs that require pumping heavy and thick liquids which must be discharged at a distance away from the pump. The pump is fitted with discharge hose connections, and the ball valves and chambers are designed to prevent fouling by sticks, stones, rags, and so on.

The WATER HOG, on the other hand, is used for pumping thinner and less viscous liquids. It can, nevertheless, handle liquids containing sand, gravel, mud, etc. The discharge outlet from the water hog is open to permit free flow and increased discharge capacity. Thus, the liquid is discharged directly at the pump. A discharge hose, however, can be fitted to the pump if desired, but this will reduce its efficiency somewhat.

Centrifugal Pumps

A centrifugal pump works as a result of centrifugal force created by a high speed impeller (see fig. 10-25). This pump is used for low pressure and large volume pumping of sewage or fuel. A centrifugal pump must usually be primed (filled with liquid) before starting.

The basic centrifugal pump has only one moving part: a wheel or impeller which is connected to the drive shaft of a prime mover and which rotates within the pump casing. The design or form of the impeller may vary somewhat. However, whatever its form, the impeller is designed to impart a whirling or revolving motion to the liquid in the pump. When the impeller rotates at relatively high speeds, sufficient centrifugal force is developed to throw the liquid outward and away from the center of rotation. Thus, the liquid is sucked in at the center or eye of the impeller (center of rotation) and discharged at the outer rim of the impeller.



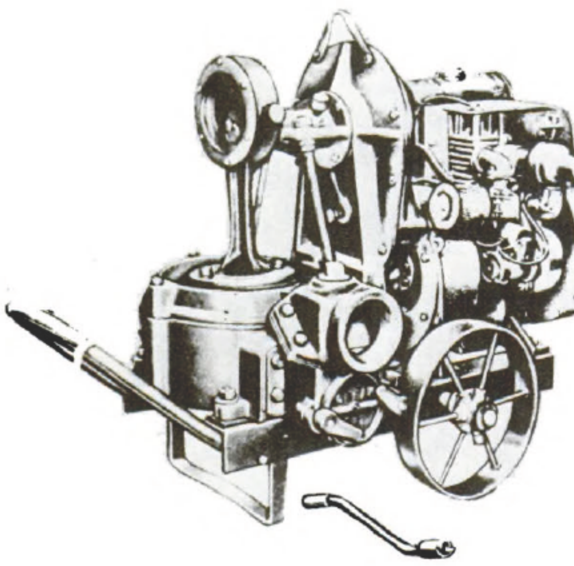
38.98

Figure 10-23. — Single-acting reciprocating pump (steam-driven).

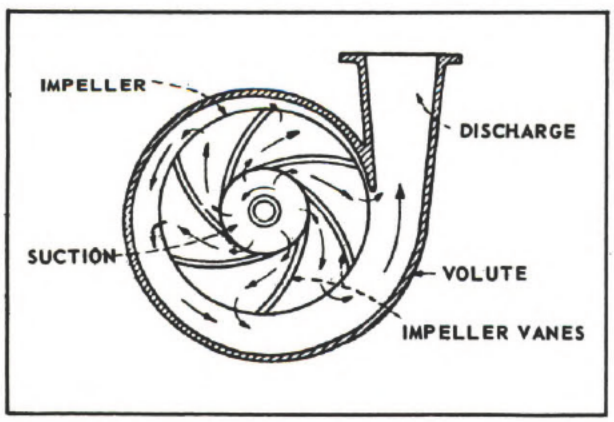
Rotary Pumps

All rotary pumps work by means of rotating parts which trap the liquid at the suction side of the pump casing and force it through the discharge outlet. Gears, screws, lobes, vanes, and cam-and-plunger arrangements are commonly used as the rotating elements in rotary pumps.

Rotary pumps (positive displacement) are most useful for pumping oil and other heavy



54.21
Figure 10-24.—Portable diaphragm pump.



23.18.0(54)
Figure 10-25.—Volute-type centrifugal pump.

viscous liquids. They are also used for non-viscous liquids, such as water or gasoline, where the pumping problem involves a high suction lift. Rotary pumps are used for fuel oil service, fuel oil transfer, and lubricating oil service. These pumps are self-priming, because they are able to remove air from the suction lines and produce a high suction lift (or a satisfactory vacuum).

Air Lift Pumps

Another type of pump which you may come across is the AIR LIFT pump. The air lift pump operates on the principle that water mixed with air becomes lighter, or is more buoyant, than water which contains no air. This pump is so constructed that compressed air is led down an air pipe to a nozzle or footpiece far below the water surface in the well (see fig. 10-26).

The air lift pump has no moving parts or prime mover similar to those utilized by the pumps described earlier; its ability to draw water is derived mainly from the compressed air. Use of the air lift pump is confined entirely to well pumping.

WATER PURIFICATION

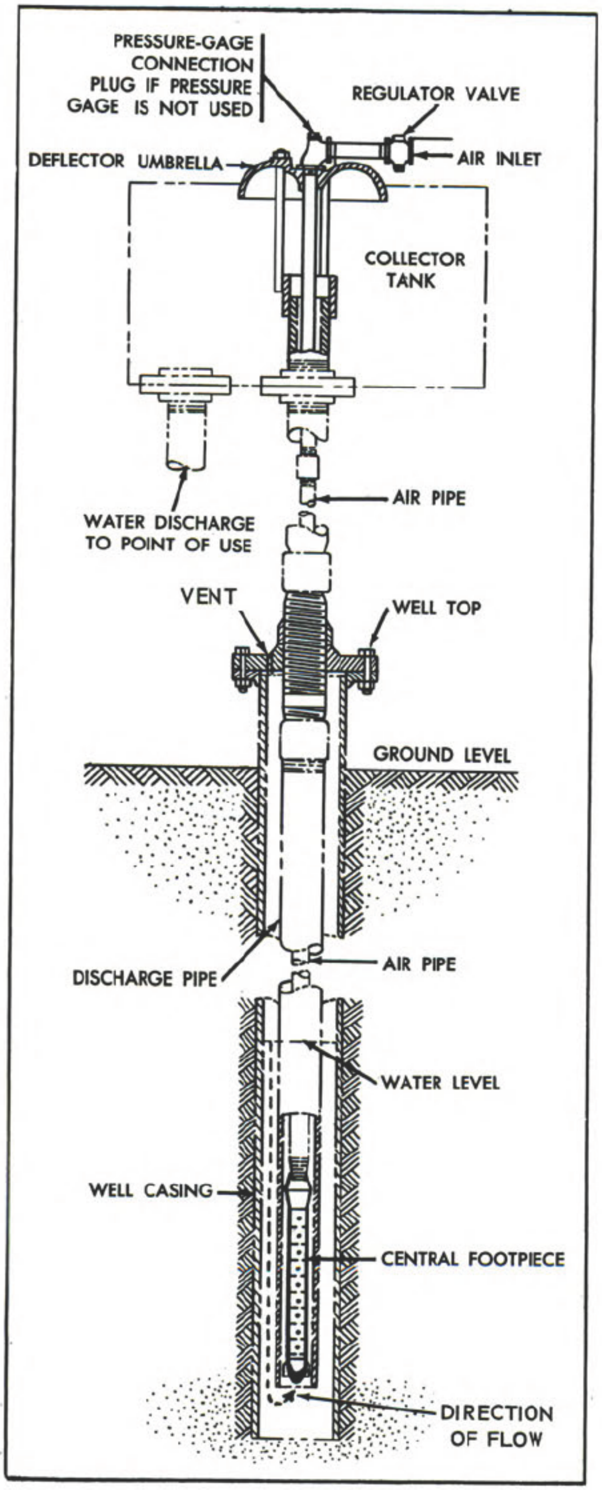
Water taken from any source (water point) is assumed to be CONTAMINATED. Impurities and germs may be present in suspended, dissolved, or sediment form. Impurities caused by chemicals and industrial wastes may be poisonous. Water-borne diseases such as diarrhea, dysentery, typhoid, cholera, and the like must be detected and eliminated before they have a chance to get into the distribution system.

Water Treatment

Among the treatments given for the purpose of purifying water are sedimentation, filtration, disinfection, taste and odor control, and (in some cases) distillation.

SEDIMENTATION requires storing the raw water in a sedimentation tank long enough to allow the suspended solids to settle to the bottom as sediments. Chemicals may be added to the water to cause the suspended solids to coagulate and hence help in rapid settlement, or in some cases the chemicals cause the solids to float as scum after coagulation. This scum is allowed to collect at a specially designed floating barrier where it is pumped out from time to time.

Solids remaining in the water after sedimentaton and coagulation are removed by FILTRATION. The water is sent through a filter, which allows the water to pass but screens out the solids. The filter usually consists of layers of gravel, and coarse and fine sand. Filtration may also be accomplished with the use of a commercial diatomite filter—using diatomaceous earth.



54.198
Figure 10-26.—Central air lift pump.

DISINFECTION means the destruction of disease-causing organisms. This may be accomplished by boiling; however, for large quantities of water, chemical disinfection is more practical. Chlorine is the most commonly used chemical disinfectant. It may be added to the water in powdered or in gaseous form. Chlorine is poisonous and must not be inhaled.

Disagreeable TASTES AND ODORS may be removed by aerating—that is, by spraying the water in the air or streaming it over cascades or steps. Or taste and odor may be controlled by passing the water through beds of activated carbon—usually in the form of steam-processed charcoal.

Salt water, contaminated water, or water containing large quantities of fine solids difficult to remove by sedimentation and filtration, may have to be DISTILLED. In distilling the water is converted to steam by boiling, and the steam is trapped in a condenser, where it is reconverted to water. The impurities remain in the boiler.

Portable Water Treatment Units

An outfit moving from one uninhabited place to another must obtain its water from whatever natural sources are available. Consequently, it must be equipped with portable water-treatment equipment.

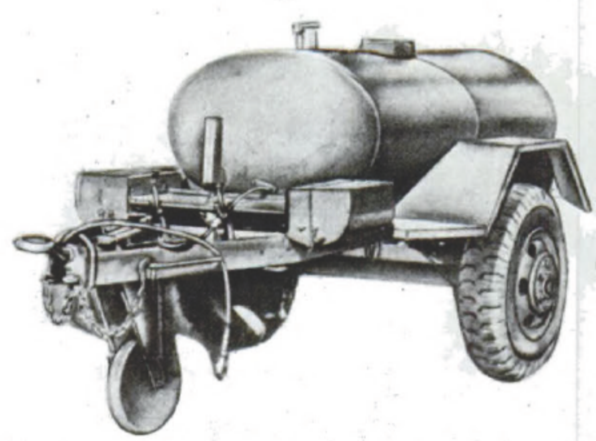
A LYSTER BAG (fig. 10-27) is a sturdy, watertight canvas container which can be easily collapsed for packing. Each bag will satisfy the water needs of 99 men, the water being drawn off through small faucets at the bottom.

Two chemical kits for purification are supplied with each bag. A kit contains one hundred 1/2-gram tubes of calcium hypochlorite, 100 sodium sulfide tablets, two chlorination test kits, and other items, together with instructions.

TANK TRAILERS, like Lyster bags, also are designed primarily as dispensing units for potable water. Where necessary, however, tank trailers may be used to disinfect raw water. The water is treated the same way as with the Lyster bag. A tank trailer (fig. 10-28) holds approximately 300 gallons of water. The unit is equipped with faucets for dispensing the water. Water from the tank trailer may sometimes be transferred to Lyster bags. The tank trailer must be thoroughly cleaned and disinfected before it is filled with water.

Individuals or small detachments such as initial landing units, patrols, parachute troops, or stranded personnel, who must use water

54.87
Figure 10-27.—Lyster bag.



54.88
Figure 10-28.—Tank trailer.

more or less as they find it, are provided with portable water filters, each consisting of a hand pump and a filter unit. The equipment can filter 2 quarts of water per minute.

STEAM BOILERS

As a CN, you may be assigned with the utilities division and assist in standing boiler watches. Your duties, as a helper, will also probably involve housekeeping and assisting the UT in performing routine operational checks, such as cleaning boiler firesides and watersides, repairing leaks, lubricating equipment, tightening loose fittings, checking fuel and water gages, and maintaining the boiler room log.

Boilers supply steam or hot water for heating, cooking, and other needs.

Two common types of boilers are the water-tube boiler and the fire-tube boiler. In a water-tube boiler the water is heated in tubes, which are surrounded by fire and hot gases. In a fire-tube boiler the tubes contain the fire and hot gases, while the water surrounds the tubes for heating. Large, permanently located boilers are likely to be of the water-tube type. Smaller, portable boilers are mostly of the horizontal or vertical fire-tube type. (See fig. 10-29.)

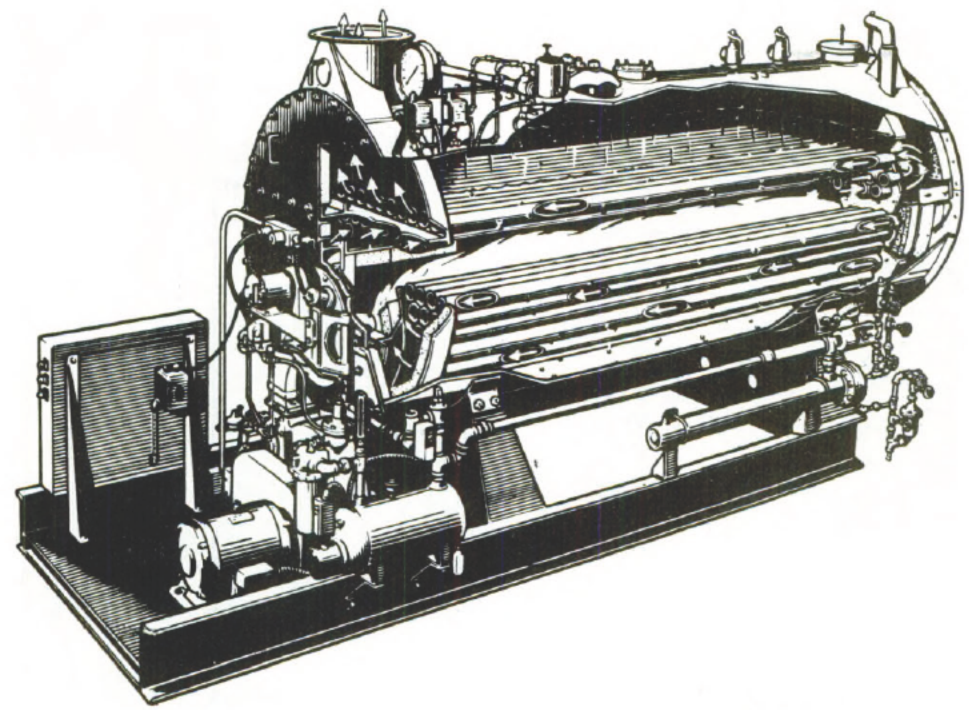
The amount of water in a boiler must be constantly controlled. The water level is indicated on a glass water gage (the correct level is usually the mid-point on the glass). Too little water causes overheating and loss of steam—if the water level falls drastically, the boiler may explode. If the water level is too high, some of the water may not be converted into steam, but may instead by carried out into the steam line, where it may damage equipment.

Most boilers have automatic feed-water regulators of the float or electrode type. Even with these, the water gage must be periodically observed, to ensure that the regulator is functioning properly. In the absence or malfunction of a regulator, water supply must be controlled by a hand-operated valve.

Every boiler has a safety valve which will "pop off" (open automatically to release steam) if steam pressure should accidentally exceed the safety point. In the absence of this device, excessive steam pressure would cause the boiler to explode.

Boiler water must be treated to protect boilers and condensate return systems (steam which has cooled so as to again become water is called condensate) from corrosion and scaling.

Boiler water is tested periodically. An alkalinity test is made daily. Soap-hardness tests reveal whether or not the water treatment is removing scale-forming salts satisfactorily. A sulfite residual test indicates the extent to which oxygen corrosion is being controlled.



54.114
Figure 10-29. — Scotch marine type fire-tube boiler.

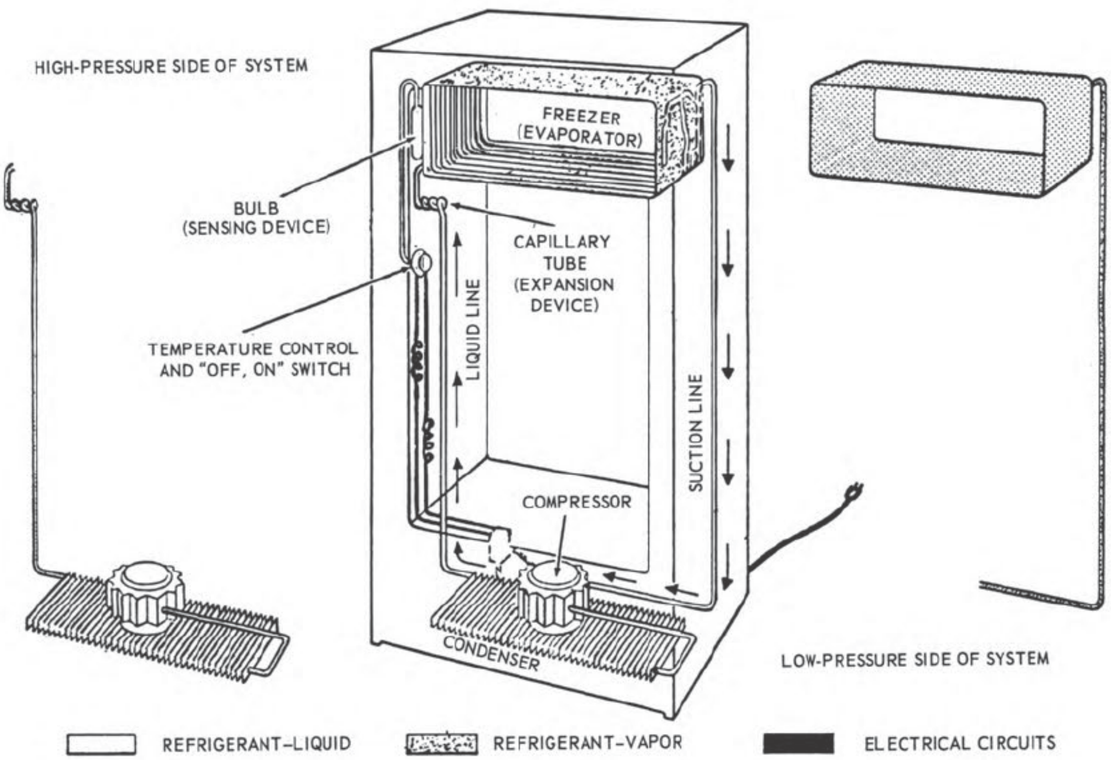
REFRIGERATION AND AIR CONDITIONING

A refrigeration and an air-conditioning unit are similar in that each unit is made up of four basic parts: compressor, condenser, expansion device, and evaporator. Figure 10-30 is a schematic drawing which shows how the cycle of refrigeration works in an ordinary home refrigerator. Tubing conveys the REFRIGERANT through the cycle of events. A temperature sensing device and an electrical temperature regulating device (temperature control) maintain the evaporator temperature by starting and stopping the compressor motor.

The principle of refrigeration is based on the EVAPORATION of a liquid (refrigerant). This is perhaps best explained by the cool sensation you feel when you apply alcohol or ether to your skin. Since these substances have a very low boiling point, your body temperature is enough to cause them to boil and hence evaporate rapidly — leaving the effect of a sudden drop in temperature. In the refrigeration system, the refrigerant expands, evaporates and absorbs heat when it passes through the evaporator, and carries the heat out of the system (refrigerator).

There are many types of refrigerants; the most commonly used are FREON and AMMONIA. SEABEES, however, generally use Freon — commonly known as Freon-12. A good refrigerant must absorb a large quantity of heat, have a low condensing temperature, and have a low boiling point (evaporating temperature).

The COMPRESSOR is the heart of the refrigeration unit. It draws the refrigerant vapor (in a gaseous state) from the EVAPORATOR (see fig. 10-38). The vapor is compressed to a certain pressure and temperature higher than the surrounding (atmospheric) air. The increase in pressure and temperature causes the vapor to condense (liquefy). By the way, the increase in temperature, in this case, is due to compression. When gases are confined and the volume is reduced, more friction among the molecules occurs, thereby causing the increase in temperature. When this compressed vapor passes through the condenser tubing, it gives off heat and condenses.



47.90(29E)
Figure 10-30.—Cycle of refrigeration.

The CONDENSER consists of a series of turns of tubing with metal fins attached so that a maximum amount of metal is in contact with the vapor and air to remove compression heat and hence lower the temperature. Sometimes fans are used to move air for condensing the vapor.

The refrigerant moves from the condenser through the liquid line to the EXPANSION DEVICE at the inlet side of the evaporator. The tubing in the EVAPORATOR is larger than the liquid line so that the refrigerant expands (changes from liquid to vapor) as it passes through the evaporator. The compressor also draws vapor through the suction line—causing a low pressure area at the evaporator outlet side.

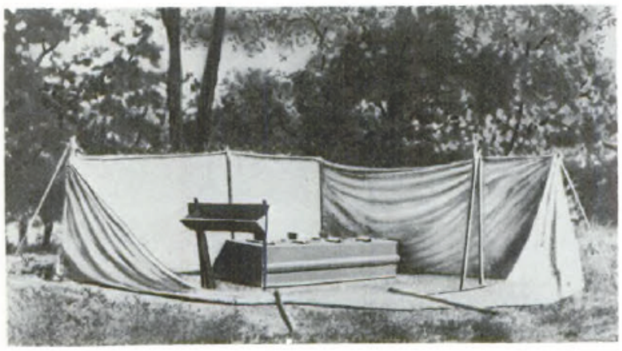
Temperature changes in the evaporator cause the fluid inside the SENSING DEVICE to expand or contract. This causes mechanical movement of bellows inside the regulating device. This movement makes or breaks an electric switch contact which, in turn, starts or stops the compressor motor. The amount the bellows move in order to affect the motor depends upon the temperature control setting. The stopping and starting cycle of events occurs and reoccurs to make the refrigerator completely automatic.

Keeping the condenser clean and maintaining proper air circulation around the refrigerator box is the best way to prolong the unit's life and dependability.

SEWAGE DISPOSAL

The removal, processing, and disposition of sewage—that is, sink, bath, and toilet drainage; industrial waste; and other material which flows into and through a sanitary sewer—is another responsibility of the Utilitiesmen. Sewage consists of about 1 percent actual waste material and about 99 percent water. It must be collected, processed, and disposed of under conditions which ensure that it does not contaminate the water supply, spread disease, or cause offensive sights and odors.

Upon arrival at an advanced base area, temporary measures are taken for the disposal



29.225
Figure 10-31. — Field latrine with urine trough.

of human wastes — such as the installation of the types of latrines shown in figures 10-31 and 10-32. Figure 10-31 shows one type of DEEP PIT latrine that is adequate for use by several men. However the prefabricated 4-seat latrine box illustrated in figure 10-32 is the type generally used by the SEABEES.

Straddle trench latrines may also be used. These are trenches about 1 foot wide and 3 feet deep. No seats are provided and the men stand along the sides. Boards may be placed around the sides to help keep steady footing.

The earth that is dug out is piled at one end of the trench. Each man covers his excreta and paper with some of the dirt. When the latrine is filled to within 1 foot of the ground level, or is to be abandoned, it is closed. Tightly packed earth is placed over it.

If there is a possibility that others may come into the area, it is better to mark the closed latrine so that the site is not used again. A sign CLOSED LATRINE with the date of closing should be placed firmly in the earth over the spot.

If the base is to be maintained for numerous personnel, a sanitary sewer system may be installed, with final disposition of waste by dumping into the sea or into a septic tank. In a septic tank, sewage is made harmless and is decomposed by bacteriological action.

For a large permanent establishment where sea disposal of sewage is impossible or impracticable, a sewage disposal plant is set up. Such a plant may subject sewage to "primary" treatment only, or there may be both primary and "secondary" treatment.

UTILITIES SAFETY

Safety deserves careful consideration when working with Utilitiesmen. Some precautions to be observed are given below.

Wear protective clothing, such as coveralls, gloves, safety shoes, and leggings, on jobs where required.

Pile pipe away from walks or roadways and always on racks, or sills. Block pipe so it CANNOT roll.

When lifting pipe or anything heavy, bend the knees, keep the back line as nearly vertical as possible, and hold the load as close to the body as possible. Lift with the legs, NOT WITH THE BACK.

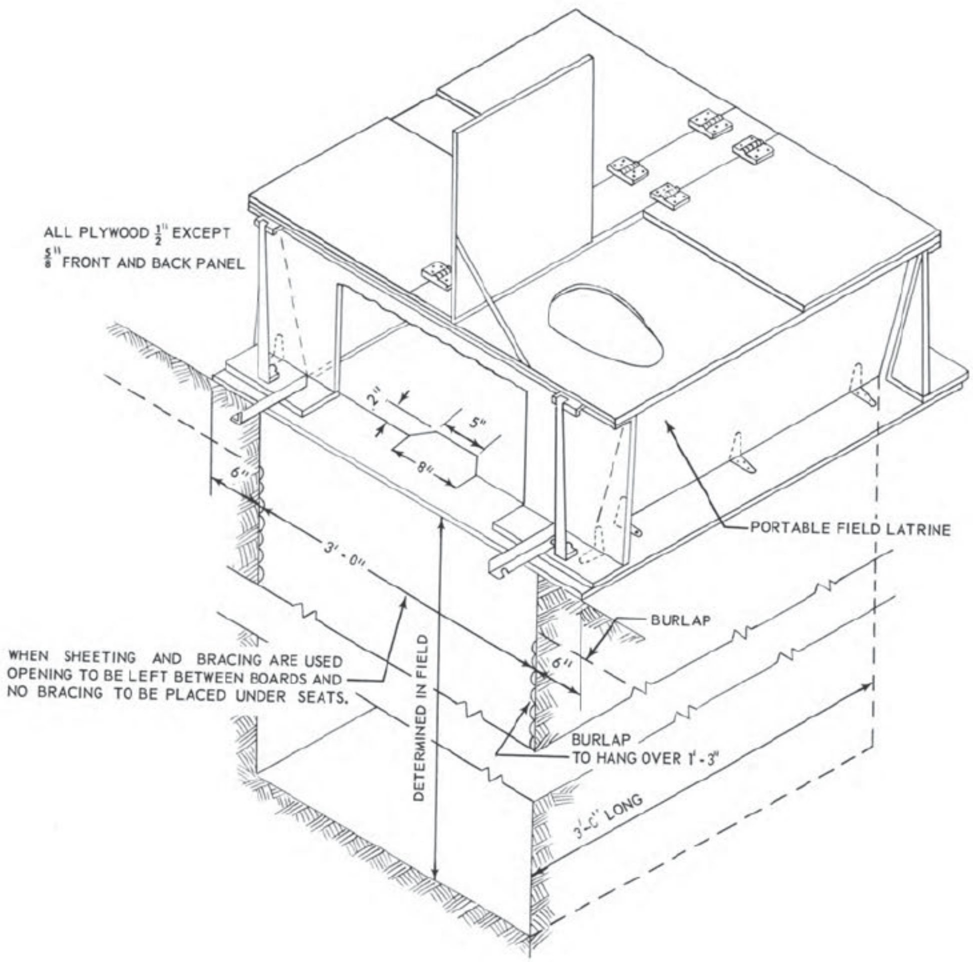
Pipe being transported on a vehicle must have a RED warning flag on any projecting ends.

Use extra care when handling threaded pipe to prevent flesh cuts. Use mechanical assistance such as block and tackle, chain falls, tongs, or other lifting devices when handling heavy pipe and fittings. Installed piping must not be used for securing chain falls to lift or support weight.

Not just the main in charge, but everybody around a steam boiler — including yourself — keeps an eye on the water gage to ensure that a low-water explosion doesn't occur. Before a boiler is lit off, it must be ascertained that no personnel are inside the firebox, and that no tools or other articles have been left inside. Everybody, too, keeps an eye out for leaks.

Chemicals used in a water purification plant must be carefully and conspicuously labeled, and the greatest care must be taken to ensure that ONLY the correct amounts of the correct chemicals are added to the water. Chlorine gas, being poisonous, must be handled carefully. During cold weather, pipes and equipment must be prevented from freezing — a frozen water pipe is likely to burst.

At a sewage treatment plant there is a constant danger of infection of any open cuts you might have — therefore, you must keep cuts or scratches covered. Remember that sewer or sludge-digester gas is as explosive as gasoline vapor. It is also toxic (poisonously suffocating)



133.189
Figure 10-32.— Prefabricated 4-seat latrine box.

in manholes or other confined spaces. Never enter such a space without ensuring that it is gas-free.

The only safe way to operate utilities equipment (or any other equipment, for that matter) is strictly in accordance with the manufacturer's instructions. Never use an air compressor for clothes cleaning or for practical jokes. Before a compressor is cut in to the prime mover, it must be ascertained that all hose lines are well connected. Otherwise a hose may blow off and injure somebody.

CHAPTER 11

ELECTRICITY

Men in the Construction Electrician rating are responsible for providing the electric power required for lighting and for the operation of electrical equipment (including telephone equipment) at advanced bases. These men install, operate, maintain and repair generators, transformers, switchboards, motors, and other electric equipment. They erect poles, string wires, install and maintain interior wiring, and perform all other duties related to the operation and maintenance of electric power distribution systems. They install conduits, fixtures, and associated electrical equipment. They pull and splice wire and cable. The job of installing, operating, and maintaining advanced base telephone systems, public address systems, and interoffice communications systems is also handled by the Construction Electricians.

A CN may be assigned as Construction Electrician's helper in any of these activities. Most CNs striking for CE, however, are engaged in electric shop work or in the fields of power distribution and generation.

ELECTRICAL MATERIALS

As an electrician's helper, you should be able to identify common types of materials and know the purpose for which each is used. Some of the common types that may concern you in your work are discussed briefly below.

CONDUCTORS

In the broad sense the term "conductor" means any material which will conduct electricity (glass and rubber will not; most metals will). However, to an electrician the term usually means wire or cable.

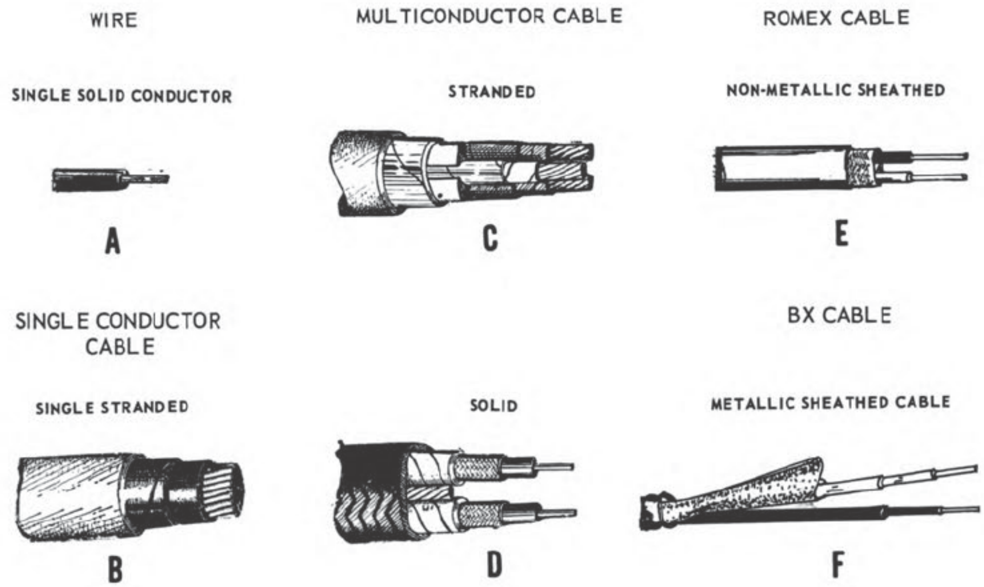
The distinction between wire and cable is illustrated in figure 11-1. Wire consists of a single, solid strand (fig. 11-1, A). Cable is defined as a single conductor which is made up of several strands of wire not insulated from each other (fig. 11-1, B). When two or more conductors (solid or stranded) are enclosed in a common sheath (fig. 11-1, C and D), they are also called cables, but are referred to as multiconductor cables.

There are three common types of wire and cable which are used most often. They are: thermoplastic wire, non-metallic sheathed cable (Romex), and metallic sheathed cable (commonly called BX). Thermoplastic wire (fig. 11-1, A) is a single conductor covered with a heat-, weather-, and moisture-resisting plastic. Nonmetallic sheathed cable (fig. 11-1, E) has two or more rubber- or plastic-covered conductors enclosed in a braided, heat- and moisture-resistant sheath. Metallic sheathed cable (fig. 11-1, F) consists of two or more rubber- or plastic-covered conductors enclosed in a flexible, spirally wound, metallic sheath.

CONDUIT

A conduit may be a pipe, a tube, or other material in which electrical and telephone wires and cables are run through for their protection from accidental damage and from the elements.

There are three types of conduit which are most commonly used. They are: rigid, thinwall, and flexible (trade name, Greenfield) conduit. An installation of thinwall conduit is shown in figure 11-2. Rigid conduit (so called because of the thickness of the walls) can be cut and threaded and uses threaded couplings and fittings. Thinwall conduit, as the name implies, is very thin and cannot be threaded. It must be installed or connected by use of compression fittings. Flexible conduit is a flexible, hollow, spirally wound metallic tube, similar to metallic sheathed cable (fig. 11-1, F), except that it contains no wires. Rigid and thinwall conduit come in standard 10-foot lengths. Flexible conduit comes in a coil.



29.226
Figure 11-1.— Wire and cable.

BOXES

Boxes have many uses in the field of electrical work; however, only the most common types and their uses are discussed here. They are most commonly used as junction or fixture mounting boxes. Figure 11-3 shows outlet and junction boxes. A fixtures box is used for mounting and connecting outlets, switches, and light fixtures. A junction box (sometimes called a pull box) is used for terminating conduit runs and provides a space for holding wire splices.

Boxes come in various sizes and shapes but all types can be used for either junction or fixture mounting boxes, depending on the type of box called for. A junction box has a blank metal cover and a fixture box usually has a cover with a hole or holes in it for accommodating the fixture.

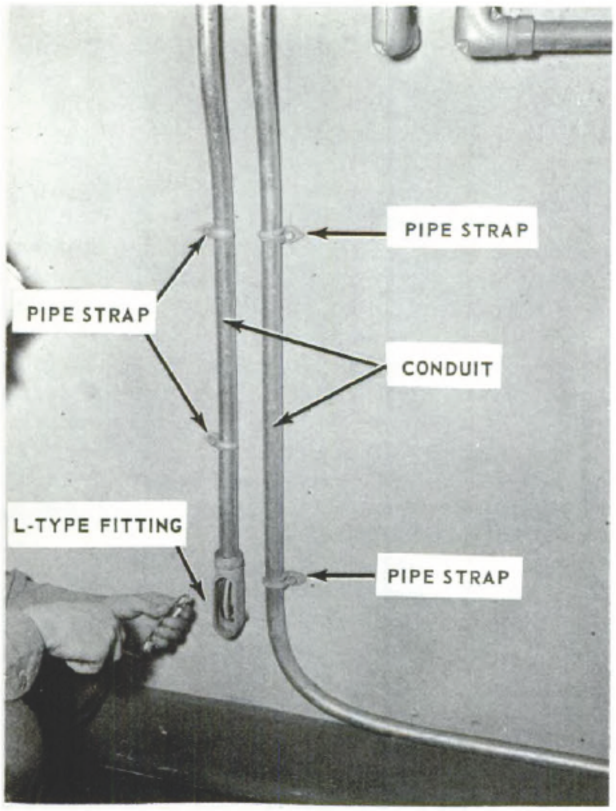
In figure 11-3, a run of conduit is shown which feeds four outlet boxes on the front of a workbench. The conduit comes up through the floor, enters two junction boxes, and then continues on to the outlet (fixture) boxes. The cover of one junction box has been removed so you can see the wire splices inside. The cover of one outlet box is also removed. You can see that the only difference between an outlet box and a junction box is the fact that the cover of the outlet box has a convenience outlet, while the cover of the junction box does not.

WIRE SPLICING

The term SPLICE means simply, joining together of two wires or cables. There are various types of splices but the most commonly used types are the Western Union, the fixture joint, and the rat-tail joint. A number of different types of splices are discussed below.

WESTERN UNION SPLICE

Small solid conductors may be joined together with a very simple splice known as the Western Union. In most instances you can twist the wires together with your fingers and finish the ends off with pliers. Figure 11-4 shows the steps in making a Western Union splice. In step 1 you remove the insulation for a length of about 3 inches and clean the conductors. Figure 11-5 shows the right and wrong ways of "skinning" a wire. You pass a knife blade through the insulation almost parallel to the wire. Don't cut the insulation at right angles because if you do the knife will nick, and thus weaken, the wire.



29.227
Figure 11-2. — Thinwall conduit for interior wiring.

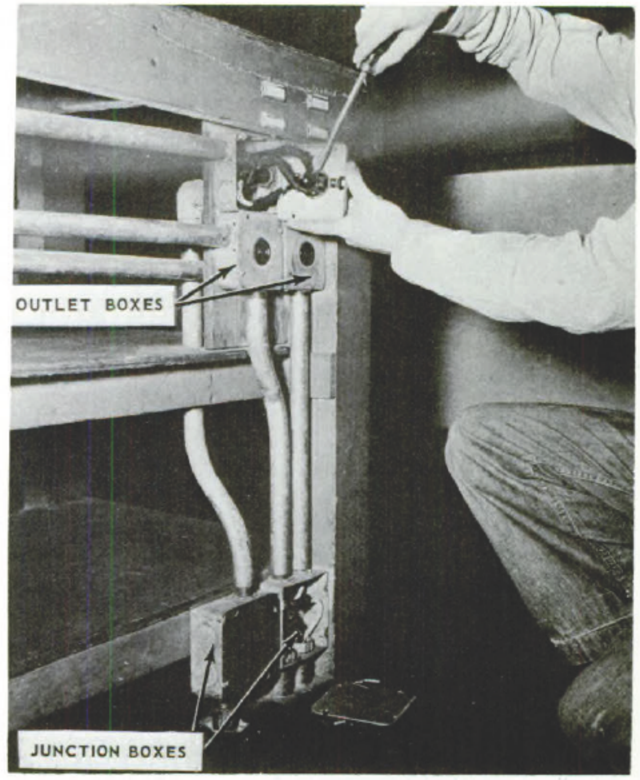
Skinning knives should not have sharp points. Knives with metal shanks extending through the handles should not be used.

DUPLEX SPLICE

Figure 11-6 shows a duplex splice for joining small two-wire cable. Each splice is a simple Western Union splice, but the splices are staggered as shown, so that the joint will not be too bulky. You skin one wire for about 5 inches and the other for about 3 inches.

RAT-TAIL JOINT

A rat-tail (or pig-tail) joint, made as shown in figure 11-7, is the splice commonly used for joining wires in an outlet or a junction box.



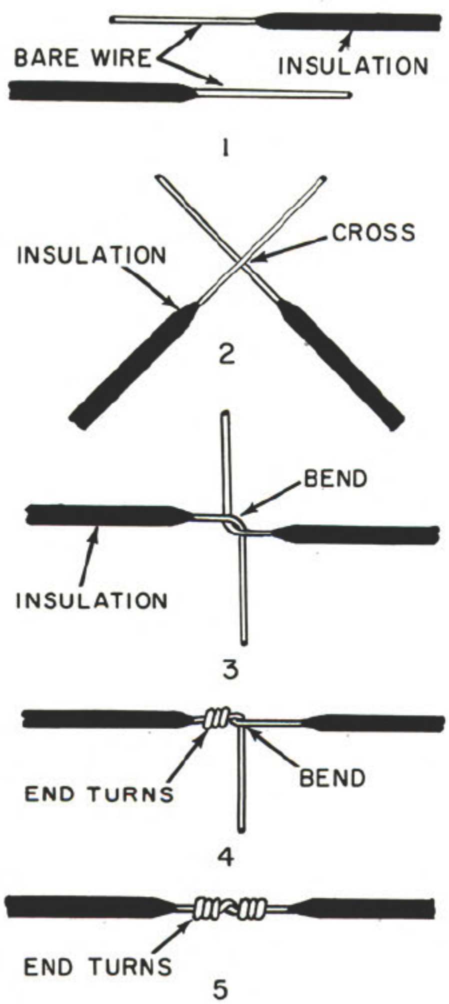
29.228
Figure 11-3. — Outlet and junction boxes.

FIXTURE JOINT

A fixture joint, made as shown in figure 11-8, is the splice used to join the wires of a lighting fixture to the wires of a branch circuit. There are usually two of each; only one wire is shown being spliced in figure 11-8. You skin the fixture wire for about 3 inches and the branch wire for about 1 inch. You take 4 or 5 close wrapping turns with the fixture wire around the branch wire (step 3), hook the end of the branch wire back (step 4), and then wrap the fixture wire around the hook.

KNOTTED TAP

The splices previously described are used to join two wire ends. The knotted tap, made as shown in figure 11-9, is used to join the end of a branch wire to a continuous main wire. You hook the branch wire over the main wire (step 3), and bring it down, under, and then over its own



73.255X
Figure 11-4.—Steps in making a Western Union splice.

part to form a knot (step 4). Then finish with wrapping turns as shown in step 5.

TAPING THE SPLICE

Once a splice has been made, it has to be covered or insulated. This is done by wrapping each splice, individually, with tape.

The most commonly used types of tape are rubber, plastic, and friction tape. Rubber and plastic tape are easily recognized by the appearance and the texture of the material. Friction tape is a cotton cloth which has been soaked with a sticky rubber compound.

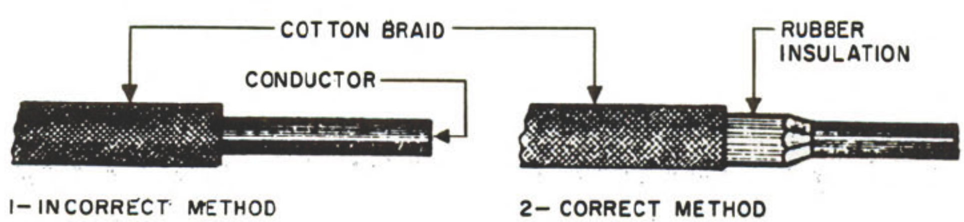
The correct method for taping is to apply the rubber or plastic tape in overlapping turns with a slight tension, so that each turn presses tightly against the one underneath it. Once this is done you cover the rubber or plastic tape with friction tape using the same procedure over again.

INTERIOR WIRING

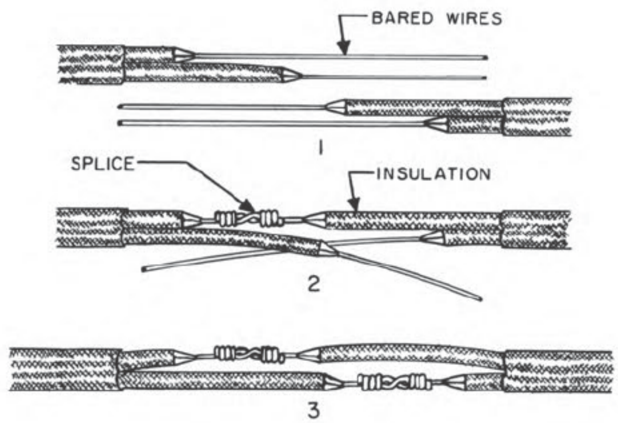
At a naval installation, the electrical system consists of a power plant which supplies electricity, a distribution system which carries electricity to the consumer, and a wiring system where the electricity is utilized. This wiring system is usually referred to as INTERIOR WIRING.

The interior wiring system starts at the point where electricity enters the building and includes all conduits, wiring, fixtures, and other electric equipment in the building.

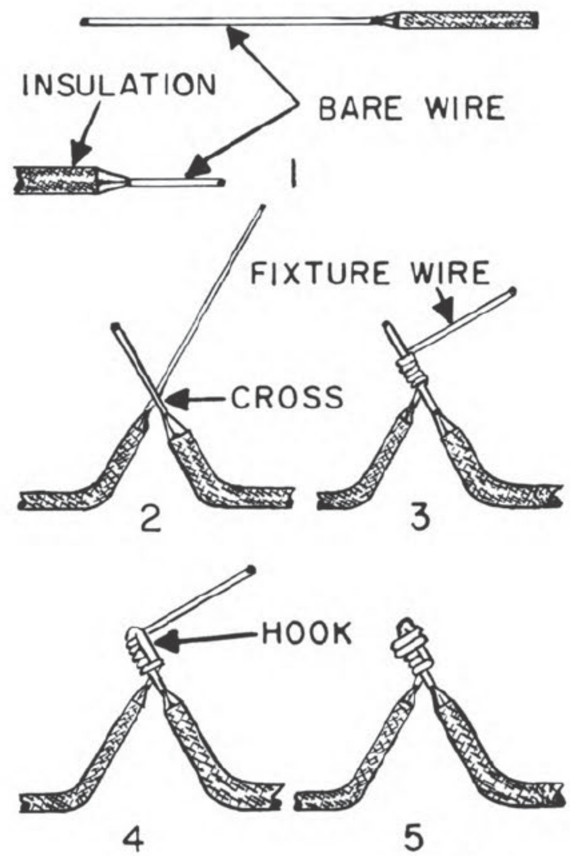
A service switch is installed at the point where electricity enters the building. From the service switch the wiring runs to a panelboard which distributes electricity to the individual circuits which are connected to the various outlets and fixtures throughout the building.



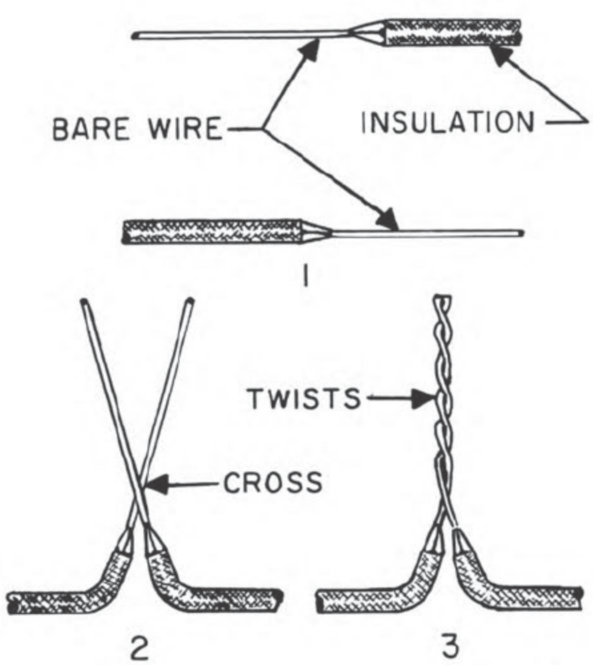
73.254X
Figure 11-5.—Right and wrong ways of "skinning" a wire.



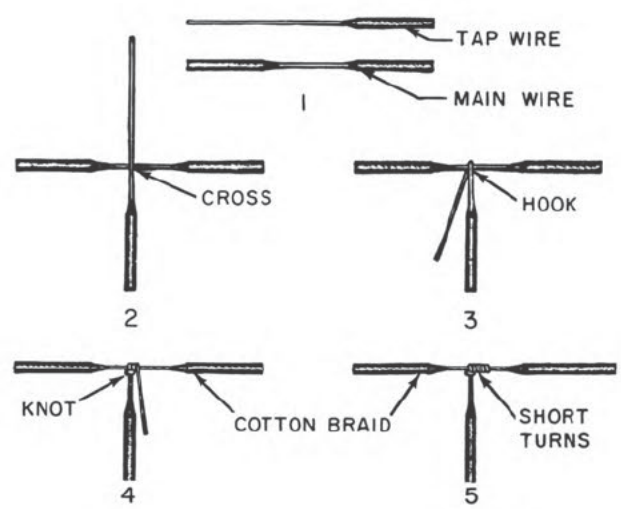
73.256X
Figure 11-6.—Making a staggered duplex splice.



73.258X
Figure 11-8.—Making a fixture joint.



73.257X
Figure 11-7.—Making a rat-tail (or pig-tail) joint.



73.260X
Figure 11-9.—Making a knotted tap.

The service switch can be opened to shut off power to the entire building. The switches in the panelboard can be shut off to secure power to the individual circuits.

A CN functioning as a CE's helper can expect to perform some of the following tasks: assist in cutting, threading, bending, and installing conduit; measure, cut, pull in, and splice wires and cables; help to install switches, fixtures, and other electrical equipment; and keep the jobsite or working area clean.

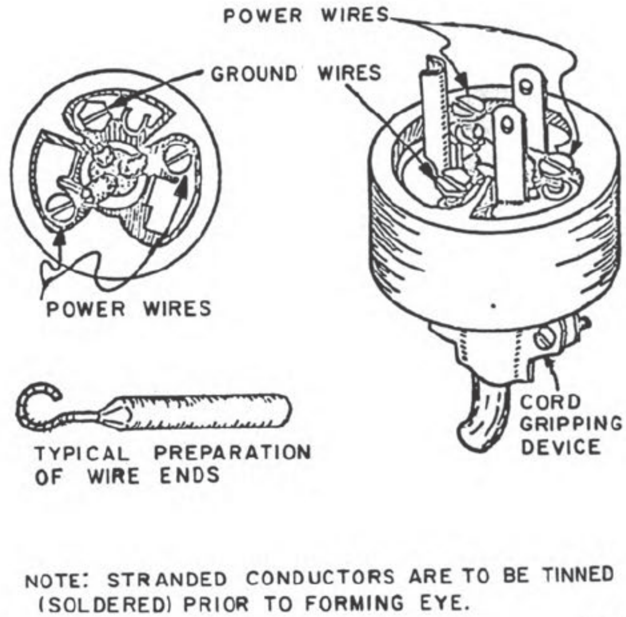
THE ELECTRIC SHOP

The principal function of the electric shop is the repair and maintenance of electrical equipment, such as appliances, switches, motors, and generators. Shops are usually equipped with electricians' handtools, test equipment, and motor and generator repair equipment.

In the electric shop the CN again serves as a general helper, materials stower, and housekeeper. Some of the duties he must perform are: cleaning the shop, stowing materials in their proper places, keeping the shop clean, and assisting the CE with repair work. He might also, under the supervisor's direction, make up extension cords, install grounds on power tools and equipment, replace plugs (fig. 11-10), and oil or grease machinery.

Making up an extension cord is a relatively simple process and the procedure will be outlined here. Figure 11-10 shows a plug, the correct way of preparing a conductor, and the method of attaching the cord to the plug. Most plugs like the one shown, have a gripping device attached to prevent strain on the terminals in the event that the plug is pulled from the outlet by someone tripping over it or by some other mishap.

To make up an extension cord, insert the cord through the opening in the plug, remove insulation (fig. 11-5), and bend a hook in the end of each of the conductors (fig. 11-10) with a pair of long-nosed pliers. Next, wrap the individual conductor around the terminal in a clockwise direction and then tighten down the terminal screw. The ground terminal is U-shaped and marked "Gr". The ground wire is green and should always be connected to the ground terminal. After the conductors are in place and the terminals are tightened, pull out the slack cord and tighten the cord gripping device.



5.13

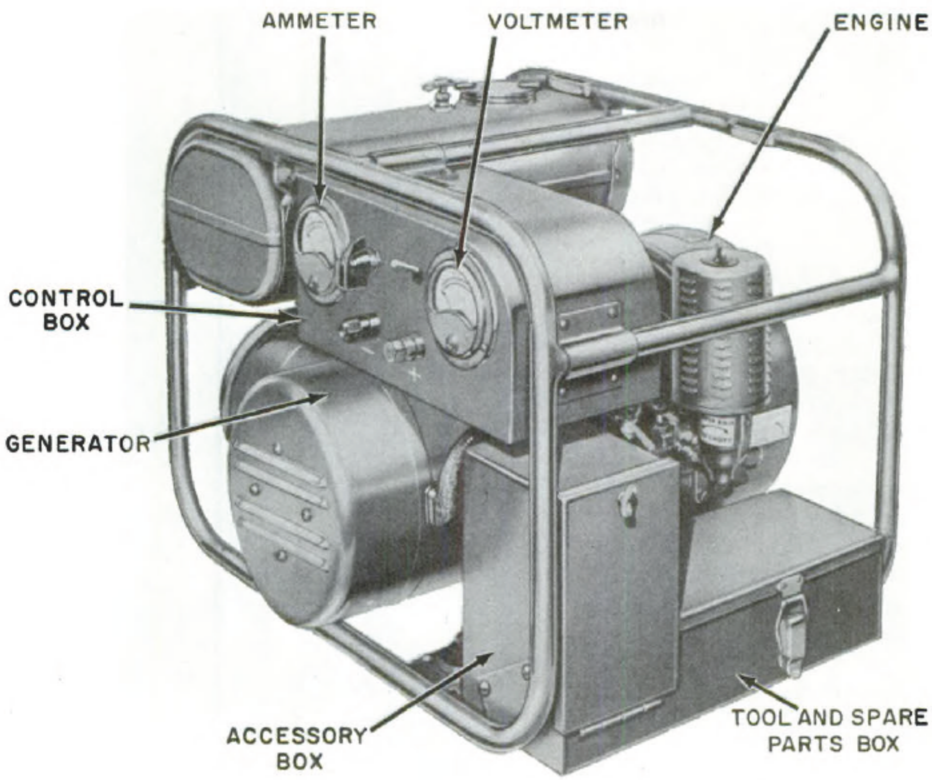
Figure 11-10.—Three-prong plug cord connection.

Extension cords should never be left laying around. They should be wiped clean with a cloth, coiled, and hung up.

GENERATOR EQUIPMENT

When an overseas base is first occupied, portable generator sets like the one shown in figure 11-11 are spot-located as needed. Later a central generator station, called a power station, is installed to serve a large area from a single location. For either type of plant, the principal parts are the generator set, the prime mover which drives the generator(s), and the switchboard for control of the prime mover and the generator output. The prime mover may be a gasoline engine or a diesel engine. The switchboard includes various meters, "rheostat" knobs for control of output, and switches as needed.

A central power station commonly contains two main generators and one emergency generator. In case of a breakdown of a main generator, power level can be maintained by cutting the emergency unit into the line. The output of the generators, controlled quantity-wise at



73.306
Figure 11-11. — Portable gasoline engine generator.

the switchboard, is collected at the "bus bars." Bus bars are rod-type or bar-type conductors, usually made of copper. From the bus bars, "feeder" lines carry the power to the operational headquarters, living spaces, supply centers, motor pool, shops, and other power-consumption points. Distribution transformers reduce high transmission-line voltage to lower consumer-outlet voltage.

At the central power station, a Construction Electrician stands a generator watch. The watchstander maintains an operational log, in which certain data — such as meter readings — are periodically recorded. Other watchstander duties are keeping an eye on generator voltage output and frequency, starting and paralleling alternators (an alternating-current generator is called an alternator), carrying out emergency procedures, keeping lubricating oil at proper level, keeping fuel tanks full, and keeping sufficient water in the cooling system.

A CN may be assigned as helper to the Construction Electrician generator watchstander. Again, one of his main duties is housekeeping — which here is a matter of prime importance, because poor housekeeping in a power plant is highly unsafe, with so much moving machinery and so many exposed high-voltage points for people to fall against.

A CN in the power plant may likewise be assigned to keeping fuel tanks filled, and to minor servicing of machinery. Care of the storage batteries used to start gasoline and diesel engines may be another CN duty. This includes checking terminals for corrosion, adding water, and taking hydrometer readings as needed. Electrolyte includes acid, and when you are handling acid, take care to avoid splashes in the eyes or against bare skin. Keep flames and sparks away from storage batteries. Do not stow acid where the temperature may go below freezing.

When working on or around electric generators, there are certain SAFETY PRECAUTIONS that must be observed for the protection of both the individual and the electrical equipment. Shirt sleeves should be buttoned and shirttails should

be tucked in when working around moving machinery. Spaces must be kept clean and oil and grease should be wiped up. Machinery guards must be in place. Jewelry and other metallic objects must be removed prior to working around electrical equipment. Always observe warning signs. Protective clothing (rubber aprons and gloves) should be worn when working around or with acid.

POWERLINE CONSTRUCTION

At an overseas base, power from the central power plant may be carried to consumer outlets in shops, barracks, office buildings, and the like by overhead transmission and distribution lines, by underground cables, or by a combination of both. At most overseas bases, power is usually distributed by pole-carried feeder lines.

Stages in erecting an overhead system are, in general, as follows: framing or otherwise preparing the poles; digging pole holes; erecting the poles; facing the poles; guying the poles; mounting crossarms; stringing the conductors; and adjusting conductors for tension and sag.

DIGGING POLE HOLES

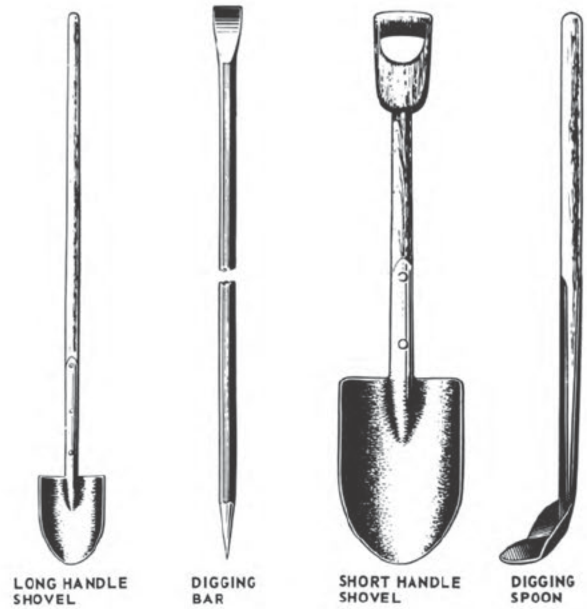
Pole holes, each slightly larger than the butt of the pole to be placed in it, may be dug with a power-driven earth borer or auger. In the absence of one of these, they must be dug by hand. Tools commonly used are shown in figure 11-12. You start digging with the short-handled shovel, shift to the long-handled one, and finally to the digging spoon, as depth increases. You break up the soil as necessary with the digging bar. The depth of a hole varies according to the length of the pole to be erected in it.

Before using hole-digging tools, check to be sure they are in good condition. See that wooden handles are strong, smooth, and free from splinters, checks, and splits. Ensure that the blades on shovels are smooth, sharp, and free from twist.

There should be adequate clearance between men using shovels so that no one will be struck by either tools or materials. The area of the ball of the foot, not the instep area, should be used to press the tool into clay or other stiff material.

Hole-digging tools should never be thrown or tossed to another person, but should be handed to him with the handle forward.

Do not leave hole-digging tools where personnel may stumble over them or trip against



29.234
Figure 11-12. — Hole-digging tools.

them. Clean the tools before returning them to their place of storage.

ERECTING POLES

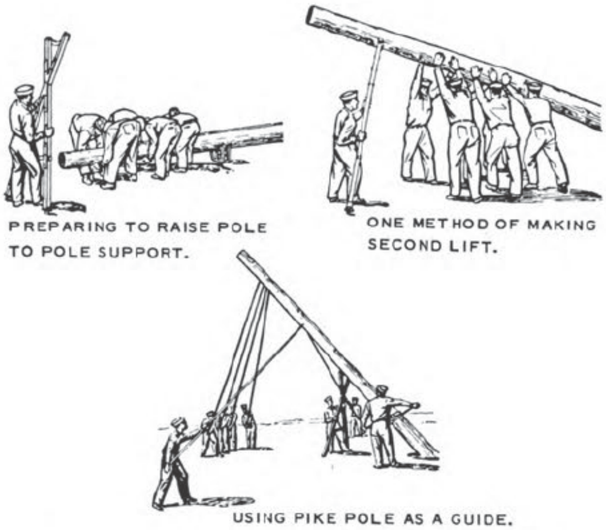
Poles are commonly raised and set in place in the holes by a truck-mounted A-frame. In the absence of an A-frame, they are heaved up by "piking," as illustrated in figure 11-13.

In piking the pole is laid with the butt at the edge of the hole. A length of plank called a BUTT BOARD, long enough to protrude above the ground when placed in the hole, is set in place, to keep the butt of the pole from sliding past, or digging into the side of, the hole as the pole is raised. The upper end of the pole is raised high enough to permit a jenny to be slid under. The pikemen then raise the pole higher with pikes, and as they do so, the jenny man slides the jenny further along. This continues until the butt drops into the hole.

FACING POLES

After raising, a pole is "faced," that is, rotated so as to bring the crossarm gain(s) into correct position.

Four pikemen hold the pole erect with their pikes, while a fifth man rotates it into position



29.236
Figure 11-13. — Raising a pole by piking.

with cant hooks, as shown in figure 11-14. The excavated earth is then backfilled into the hole and tamped down hard around the butt of the pole.

A pole is usually braced with "guys" of wire rope, the upper end of a guy being attached to a high point on the pole, and the lower end to one of several types of "anchorages" fixed in the ground.

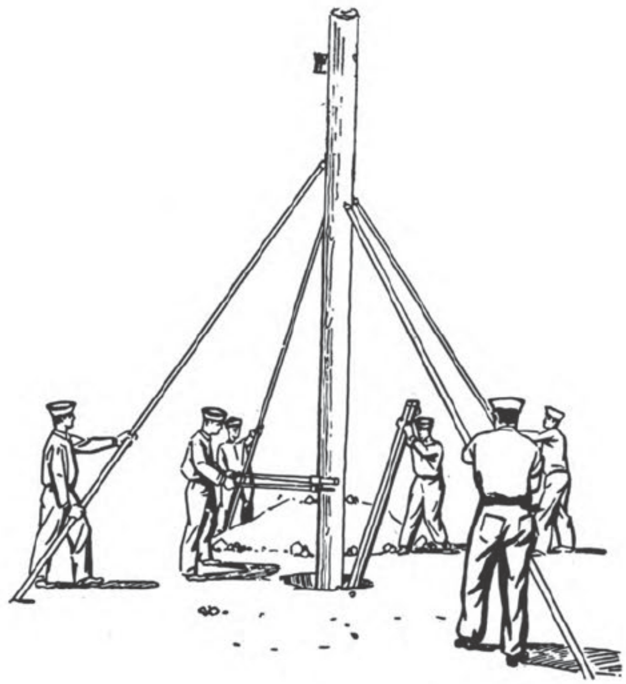
STRINGING CONDUCTORS

Conductors are strung from revolving reels. A rope hauling line is stretched along the poles and passed over the crossarms by a lineman who climbs each pole with the rope. One end of the hauling line is connected to the conductor to be strung. Turns with the other end are taken around the drum of a power winch on the line truck, and the winch hauls in the line and the attached conductor.

CEs engaged in stringing conductors for an advanced base cantonment area are shown in figure 11-15. This figure also shows the typical arrangement of electric poles in an advanced base electrical distribution system.

THE CN'S DUTIES IN LINE CONSTRUCTION

As a CE's helper, a CN may be assigned to dig pole holes, work as a groundman hoisting



29.237
Figure 11-14. — Facing a pole.

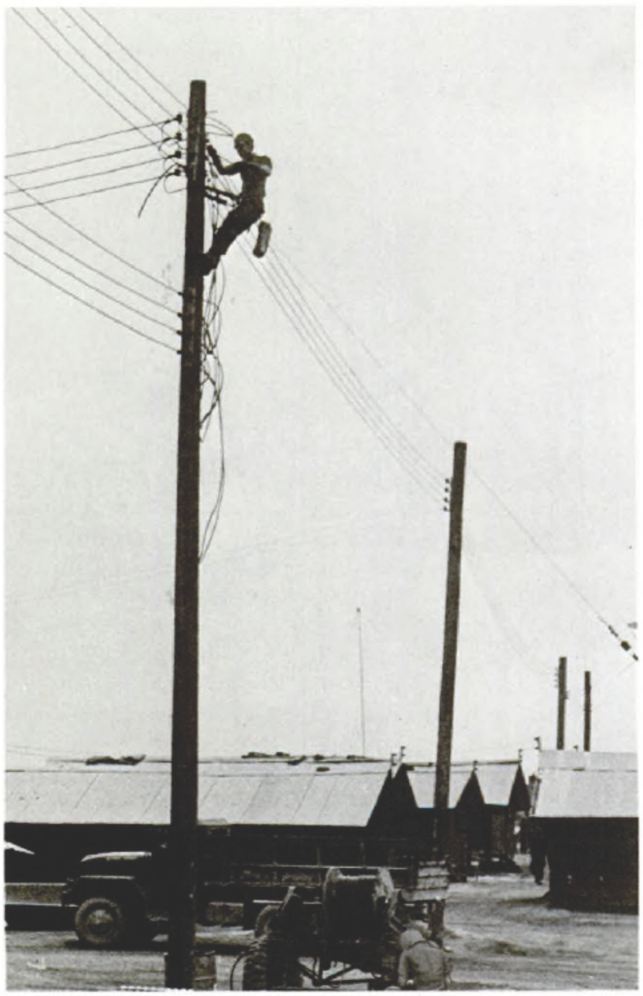
material up to the CE working on the pole, place cable reels and help pay out cable, clean digging tools and stow materials. He may also assist the CE in framing the pole on the ground, erecting the pole, facing the pole, and compacting the backfill.

LINE CONSTRUCTION SAFETY

In line work, tools and other materials should not be thrown or dropped down to personnel working on another level. They are to be raised or lowered by means of handlines or canvas toolbags or buckets. Workmen should stand clear when tools and other materials are being raised or lowered. They should not walk or stand under a load which is not properly placed and secured. All workers must wear safety helmets.

Safety lines, handlines, and other ropes or wire are not to be hung from a pole in such a manner that they can in any way interfere with traffic.

Ladders are essential construction and maintenance tools, and are used frequently by electrical personnel. Many accidents result from improper use of ladders. Portable metal ladders,



29.425
Figure 11-15.—CEs stringing wire on an electrical distribution system.

or ladders having metal hardware, are prohibited for general use by personnel inspecting or working on electric lines, poles, wiring, or equipment, both indoors and outdoors.

Ladders should be inspected at frequent intervals to assure that all rungs, braces, and side rails are secure and free of defects. If defects are noted that cannot be readily repaired, the ladder should be replaced. Ladders should not be painted as this will mask defects such as cracks and splits in the wood. For the same reason, ladders should be kept clean.

Ladders not in use should be stored where ventilation is good and where harmful weathering cannot affect them. They should not be stored near stoves, radiators, steam pipes, or other places subject to excessive heat or dampness.

ELECTRICAL SAFETY

The following safety precautions have particular application to the electrical shop; however, many of them apply elsewhere as well, given the same materials or circumstances.

Never wear rings or other jewelry when working around machines, and keep loose sleeves rolled up or close-fitting sleeves buttoned.

Keep flammable liquids in approved safety cans equipped with self-closing covers. They must be stored in an approved space which meets fire safety standards; preferably, flammable liquid storage spaces must be located outside of main buildings, such as office buildings, work shops, and the like. A shack is generally provided for this purpose.

Illumination must be sufficient to ensure safe performance of work around electrical wiring or equipment.

Before using any electrical power tool or apparatus, be sure that it has ground connection. Grounded tools are generally equipped with a three-prong plug; when not so equipped, consult your supervisor. He will show you how a ground wire may be connected if it is necessary.

Do not work on electrical apparatus with wet hands or in wet clothing, or in clothing having exposed metal buttons, zippers or other metal fastenings.

In connection with grounded power tools safety, an article that appeared in Family Safety, entitled "When the Green Wire is Condition Red," is inserted here to share with you the near-fatal personal experience of Mr. A. J. Krininger, as regards power tools hazards.

> "Some years ago, when the three-prong, three-wire system for portable electrical tools was introduced, many people thought that finally a sure answer to many accidental shock problems had been developed.
>
> "The three-wire receptacle provides—in addition to the "hot" (black) and "neutral" (white) wire—a third, (green) wire that is connected directly to a ground such as a water pipe. The

third wire goes via the third prong to the metal body of the tool so that, if an internal short should occur while the tool is in operation, the current would immediately flow to ground and the operator would be saved from possible shock.

"The three-wire system on power tools — drills, hedge trimmers, sanders and other hand-held electrical devices— has prevented hundreds of fatal accidents since three-wire safety circuits have been accepted as standard by the electrical industry. Yet the three-wire system can itself be a shocker under a certain special set of circumstances.

"Just how such a situation can come about is detailed in a letter from A. J. Krininger, manager of the aerospace division engineering support organization of the Boeing Company. Mr. Krininger's letter explains how a safety boom can boomerang.

"Mr. Krininger was alone at his summer home, using an electrical sander to smooth some patching plaster. The sander had a grounded case, one that was connected via the third prong and third wire to a grounded receptacle. After plugging in his sander he assumed he had an electrically safe tool in his hand.

"Late in the afternoon he plugged in an old indirect type floor lamp to throw more light on his work. As the job progressed, he moved the lamp around and once he moved it without letting go of the sander.

"Instantly current surged through his body. He could not release his grip from either the lamp or the sander or even open his eyes or stop his teeth from chattering. Losing consciousness, he fell to the floor. There he would certainly have died if he had not luckily fallen in such a way as to pull the lamp's plug from the receptacle.

"What had happened? The old lamp was faulty. A frayed wire touching the body of the lamp had electrified it. And the three-wire system built into the tool, instead of proving to be a safeguard, actually provided the dangerous path to ground with Mr. Krininger in the middle. The effect was the same as if he had touched the lamp and a water faucet.

"As an engineer with a vivid memory of a close brush with death, Mr. Krininger has this advice for the family handyman: When using a case-grounded electrical tool that is hooked to a three-wire protective circuit, don't touch any other electrical device.

"This type of risk would not be present with a double insulated tool, which does not require a grounded case."

May the above article serve as a reminder, whenever you operate those electrically powered tools. Other safety precautions follow.

NEVER work on or otherwise contact an electrical circuit without making absolutely sure that the power is off. Do not depend on insulation as protection; it may appear perfect to the eye and still be defective.

Electrical arcing can ignite oil, grease, carbon dust, and the like. Therefore, to prevent fires, electrical machinery and equipment should be kept absolutely clean and free of all such deposits.

Keep doors, aisles, passageways, and other approaches clear, so that if fire occurs there will be no obstacle to the speedy entry of firefighters and their equipment.

Several major precautions to be observed when cleaning electrical equipment are as follows:

1. Brushes, dusters, brooms, or other such articles which are used within 4 feet of electrical equipment having exposed or current-carrying parts must not themselves contain any exposed metal.
2. If a vacuum cleaner is necessary, it must be one with a nonmetallic hose and an adequate dust receiver.
3. Sandpaper and files may be used only with express approval of the petty officer in charge.
4. Use solvents only when absolutely necessary, and then only the smallest possible quantity of APPROVED solvent.

If a fuse burns out, the cause of the burnout must be determined and corrected before the burned-out fuse is replaced. The replacement fuse must have the same ampere capacity as

the burned-out fuse. NEVER use coins, metal disks, and so on, in the backs of plug fuses. NEVER short out a cartridge type fuse.

In the electrical shop, housekeeping is one of the CN's principal duties. Return tools not in use to proper stowage places, pile or stow materials neatly in designated spaces, place all flammable materials in approved fireproof covered containers, keep aisles clear and swept down, keep the shop properly ventilated, and above all, keep your attention closely on any job you have in hand.

APPENDIX I

GLOSSARY OF SEABEE TERMS

ACB — Abbreviation for Amphibious Construction Battalion.

AGGREGATE — Crushed rock, sand or gravel for use in road surfaces, concrete, or bituminous mixes.

AIR-COOLED ENGINE — An engine which is cooled by the passage of air over and around the cylinders and cylinder heads.

AMPERE — The unit of measurement of electrical current.

ANGLEDOZER — A bulldozer with a blade which can be pivoted on a vertical center pin so as to cast its load to either side.

ANGLE IRON — A structural member with an L-shaped cross section.

ARC WELDING — A welding process wherein the weld is produced by heating with an electric arc.

AREA DRAIN — A receptacle designed to collect surface or rainwater from an open area.

BACKFILL — The material used in refilling a ditch or other excavation, or the process of such refilling.

BACKFIRING — In an engine, the pre-explosion of an air-fuel mixture so that the explosion passes the still open intake valve and flashes back through the intake manifold.

BACKHOE — A crane attachment, or a separate piece of equipment, designed for digging on the pull stroke of the bucket.

BACKSIGHT — A surveying term: (1) In traversing, a sight on a previously established point or station for the purpose of determining line. (2) In leveling, a reading on a rod held on a station of known elevation for the purpose of determining the height-of-instrument (H.I.).

BASE LINE — A precisely established line of exact direction and length used in determining other directions or distances.

BATTEN — A narrow strip of board fastened over board joints.

BATTER PILE — Pile driven at an angle to brace a structure against lateral thrust.

BATTERY STARTER TESTER (B.S.T.) — A device for conducting tests on the battery and starting system.

BEAM — In building, a large horizontal structural member.

BEARING WALL — A wall supporting a load.

BEEP — Abbreviation for Battalion Equipment Evaluation Program.

BENCH MARK (BM) — A relatively permanent marker established at a known elevation for the purpose of accurate surveying. A less permanent marker is sometimes called a TBM (temporary bench mark).

BITUMINOUS MIXTURE — A mixture containing asphalt or tar.

BOARD — Any lumber that is less than 2-inches in nominal thickness.

BORROW PIT — An area near a construction site from which fill material is obtained when a sufficient amount of material is not available at the construction site.

BRACE — A diagonal member used to stiffen framework.

BRACKISH WATER — Water unfit for drinking because of salty or unpleasant tastes.

BRAKE — A device for slowing or halting the motion of any object or mechanism.

BRANCH CIRCUIT — That portion of a wiring system extending beyond the final fuse or circuit breaker.

BRIDGING — Cross bracing between adjacent floor joists to prevent buckling or transverse movement, and to distribute the load to adjacent joists.

BUILDING PAPER — A heavy paper used to insulate a building before the siding or roofing is put on; sometimes placed between double floors.

BUILDING SEWER — That part of the lowest part of the horizontal drainage piping that receives the discharge of the building drain and conveys it to the public or private sewer, or some other point of disposal.

BUILT-UP MEMBER—A single structural component made from several pieces fastened together, such as a roof truss.

BX CABLE—Multiple conductor electrical wire with a flexible metallic sheathing.

CALIPER—A measuring tool used primarily to measure the outside diameter of a cylindrical object (outside caliper), or the bore of a hole (inside caliper).

CAULK—To seal joints with a sealing compound.

CANT HOOK—A tool used for turning or rolling a log or pole.

CARBON DIOXIDE—A gas formed by the combustion and decomposition of organic matter. Does not support combustion. Used to extinguish fires.

CBC—Abbreviation for Construction Battalion Center.

CBMU—Abbreviation for Construction Battalion Maintenance Unit.

CBU—Abbreviation for Construction Battalion Unit.

CELLS—A building term: Openings in concrete block or building tile.

CERAMIC TILE—Baked clay tile generally used in bathrooms.

CHAMFER—A beveled surface cut upon the corner of a piece of wood.

CHANNEL—A structural steel member with an U-shaped cross section.

CHASSIS—That which remains when the body is removed from a vehicle.

CIRCUIT BREAKER—A protective device used to open and close an electric circuit, similar to a switch but designed to open automatically upon overload.

CLAMSHELL—A crane attachment with two open jaws which are closed to pick up material.

CLEARING—(Verb) The removal of vegetation such as grass, weeds, brush, trees, and stumps, or (noun) the area where this has been done.

CLOSED TRAVERSE—A traverse that starts and ends at the same point, or at stations whose positions have been determined by other surveys.

COAGULANT—A material which, when added to water or sewage, combines with added or naturally present chemicals to form a precipitate called floc which settles and aids in the removal of suspended matter in the liquid.

COALESCENCE—The uniting or fusing of base metal parts.

COLUMN—A high-strength, vertical structural member which supports a load.

COMPACTION—To increase the density of bulk materials by tamping, rolling, or vibrating.

CONCRETE—A mixture of cement, aggregate, and water.

CONDUIT—A pipe or a tube used to protect electrical and telephone wires and cables from accidental damage and the elements.

CONTROL STATION—A location where switches and other equipment are located for remote control of machinery.

CONTROL SURVEY—A survey which provides positions (horizontal or vertical) of points to which supplementary surveys are adjusted.

CRANE—A stationary, traveling, or mobile machine used for lifting and moving loads.

CRAWLER-MOUNTED—Refers to a machine that is mounted on tank-like treads.

CROSS BRACE—Bracing with two intersecting diagonals.

CTR—Abbreviation for central toolroom.

CTU—Abbreviation for Construction Training Unit.

CYLINDER—(1) A portable tubular container used for transportation and storage of a compressed gas. (2) A piston chamber in an internal combustion engine where the fuel is burned.

DEADMAN—A log, steel beam, or similar object, buried in the ground to function an an anchor.

DECK PLATE—In regards to pontoons: The top of a pontoon unit.

DIESEL ENGINE—An internal combustion engine which has no separate ignition system. Diesel fuel (oil) is injected and ignited by the heat resulting from the compression of air within a cylinder.

DISINFECTION—The process of killing harmful and objectionable micro-organisms by using chemicals, heat, ultrasonic waves, ultraviolet light, radiation, etc.

DISTILLATION—The process used to purify a liquid (removing dissolved solids) by heating the liquid to a vapor and then condensing it back into a liquid state.

DOUBLE-CLUTCHING—Disengaging and engaging the clutch twice during a single gear shift, to prevent the clashing of gears.

DRAGLINE—An excavating crane to which a bucket is attached only by cables, and digs by pulling the bucket towards itself.

DRAIN—To become emptied or freed of liquid by its flowing or dropping; a means by which liquid or other matter is depleted.

DUMP TRUCK—A truck that carries a box body with a mechanism for discharging its load by raising the front end of the body.

EARTHWORK—The operations involved in excavating, draining, grading, embanking, and moving earth in construction work.

ELECTRODE HOLDER—A device used for mechanically holding a welding electrode.

ELECTROLYTE—A solution of distilled water and sulfuric acid used as the active chemical in wet cell storage batteries.

ELEVATION—The vertical distance or altitude of a specific point or place above or below a reference plane.

ENGINE—A machine that converts energy into mechanical force and motion.

EQUIPMENT COMPANY—Alfa Company of an NMCB that controls, operates, and maintains automotive and construction equipment.

EVAPORATION—The process by which a liquid passes into a gaseous state.

FERROUS METAL—A metal composed principally of iron.

FID—A tapered hardwood pin used for separating the strands of fiber line during splicing operations. Also see marlinspike.

FIFTH WHEEL—The weight-bearing swivel connection between truck tractors and semitrailers.

FILLER METAL—Metal, in the form of a rod, added in making a weld.

FINISH GRADE—The final elevation required by specifications.

FISH TAPE—A round or flat steel wire used to pull a conductor or cable through a conduit.

FIXTURE BOX—A box used for mounting and connecting electric outlets, switches, and light fixtures.

FLASHING—The sheet metal that prevents leakage over windows and doors, around chimneys, and at other roof details.

FLUX—A material used in soldering or welding to prevent, dissolve or facilitate removal of oxides and other undesirable substances in order to promote the fusion of two metals.

FORESIGHT—(1) In traversing, a sight on an unknown point for the purpose of determining its location in relation to a known point. (2) In leveling, a foresight is the rod reading on a rod held on a point whose elevation is being determined.

FOUNDATION—That part of a building or wall which supports the superstructure.

FOUR BY FOUR (4 x 4)—(1) A vehicle with four wheels or sets of wheels, all engine driven. (2) A wooden structural member having nominal dimensions of 4" x 4" in cross section.

FRAME (or FRAMING)—A building term related to the basic structural portion of any building to which the various floor, wall, ceiling, and roof coverings are secured.

FRONT-END LOADER—A tractor with a bucket which operates entirely at the front end of the machine.

FUSE—An electrical protective device designed to blow or burn out on overloads or short circuits.

GABLE—The triangular portion of an end wall formed by the sloping roof.

GABLE ROOF—The roof sloping up from two walls.

GAFF—A sharp, pointed spur on climbers used for climbing poles.

GIN POLE—A hoisting rig constructed from a single pole, square timber, or steel beam. It stands almost vertical and is supported by guys.

GIRDER—A large horizontal structural member, usually heavier than a beam, used to support the ends of joists and beams or to carry the weight of walls over openings.

GIRT—A stiffening member passing around the outside of a structure, or of part of a structure, for the purpose of strengthening or protecting it.

GLAZING—Setting glass in wood or metal sash with a glazing compound.

GRADER—A machine with a centrally located blade that can be angled to cast material to either side.

GRADE STAKE—A stake indicating the amount of cut or fill required to bring the ground to a specified elevation.

GROUT—A rich mixture of cement, water, and frequently a fine aggregate (sand) used to fill small cracks or joints.

GRUBBING—Uprooting and removing tree roots and stumps.

GUTTER—A trough or depression for carrying off water.

HAND SHIELD—A hand-held protective device used in arc welding for shielding the face and neck and equipped with a suitable filter lens.

HEIGHT OF INSTRUMENT—The elevation of the horizontal line of sight of a leveling instrument. Abbreviated: H.I.

HICKEY—A manual conduit bending tool used for bending rigid conduit up to 1 1/4" in diameter.

HORIZONTAL PLANE—A plane parallel to the horizon.

HOUSE DRAIN—That part of the plumbing system which receives the discharge of all soil and waste stacks within the building and conveys it to the house sewer.

HOUSE SEWER—That part of the drainage system beginning just outside the foundation wall and terminating at the main sewer.

HUB—A surveyor's wooden stake set in the ground, with a tack to indicate the exact position. A guard stake protects and identifies the hub.

I-BEAM—A structural member with an I-shaped cross section.

INSULATION—In electrical work: Non-conducting material of various types used to cover bare electrical conductors.

JAMB—The vertical frame member of a door, window, or fireplace opening.

JENNY—A tool used to support a pole during placement.

JOISTS—Horizontal frame members which support a floor or deck and are themselves supported by sills, girders, or walls.

JUNCTION BOX—A box used for terminating electrical conduit runs and to provide space for holding wire splices; sometimes called a pull box.

LEVELING—A surveying operation used to determine the elevation of unknown points.

LIQUID WASTE—The discharge from any fixture in connection with a plumbing system which does not receive solid matter.

LOUVER—A ventilating opening covered by sloping slats to exclude rain.

LUMBER—Sawed parts of a log such as boards, planks, scantlings and timber.

MARLINSPIKE—A tool used to splice fiber line or wire rope.

MASONRY—A term generally used to describe structures of stone, brick, block, or tile but often used to describe any construction which is predominantly of cement or cement products, including plaster (stucco) and concrete.

MISSING—In an engine: the failure of a cylinder to fire when it should.

MITER JOINT—The junction of two members at any equally divided angle.

MOSAIC TILE—Baked clay tile used for pattern work on walls and floors.

NAVSCON—Abbreviation for Naval Schools Construction.

NCB—Abbreviation for Naval Construction Brigade.

NCF—Abbreviation for Naval Construction Force.

NEC—Abbreviation for Navy Enlisted Classification.

NEUTRAL—A conductor in electrical circuits which provides a return path to the source of power and usually having white insulation.

NMCB—Abbreviation for Naval Mobile Construction Battalion.

OPEN TRAVERSE—A traverse that starts at a point of known or assumed position and ends at a point whose relative position is unknown with respect to the starting point.

OXYACETYLENE CUTTING—A metal-cutting method wherein the cutting is accomplished by the reaction of oxygen and the metal at high temperatures which are obtained by the oxyacetylene flame.

OXYACETYLENE WELDING—A gas-welding process wherein a weld is produced by heating with a gas flame obtained from the combustion of acetylene with oxygen.

PANELBOARD—A panel which provides protection for branch circuits and has circuit identification.

P & E—Abbreviation for Planning & Estimating.

PIER—(1) A short, vertical structural member similar to a column which usually supports the lowermost horizontal members of a structure. (2) Intermediate support for adjacent ends of two bridge spans. (3) Structure extending outward from shore into water and used as a dock for ships.

PIKE POLES—Long poles used in raising power and telephone poles by hand.

PILE—A long, slender timber, concrete or steel structural column driven into the ground to support a structure or other load.

PILEDRIVER—A machine having a drop, steam-air, or diesel hammer with hoisting apparatus, leads and frame, used to handle and drive piles. The piledriver may be mounted on skids, a float, or a crawler or be truck-mounted.

PILE EXTRACTOR—A device for pulling piles, consisting of an inverted steam-air hammer with yoke so equipped as to transmit upward blows to the piles.

PILING—Large timbers or poles driven into the ground or the bed of a stream to make a firm foundation.

PIPE DOPE—A type of pipe thread lubricant.

PLANK—A board, 2" or more thick, laid with its wide dimension horizontal and used as a bearing surface, such as a scaffold plank.

POL—Abbreviation for Petroleum, Oil and Lubricants.

PONTOON UNITS—Specially constructed steel boxes of high buoyancy.

POTABLE WATER—Water which is satisfactory for drinking.

PRCP Abbreviation for Personnel Readiness Capability Program.

PRIMER—The first coat of paint or varnish, mixed and applied so as to fill the pores of the surface preparatory to receiving the subsequent coats.

PRIMING—The process of removing air from within a pump by filling with a fluid.

PURLINS—Horizontal members which run from rafter to rafter or from truss to truss to which a roof covering such as corrugated sheeting is secured when no sheathing is required.

QUARRY—A site where an open excavation is made for the purpose of removing rock.

RAFTERS—Horizontal or inclined frame members which provide support for a roof.

RIPPER—A towed machine or a bulldozer equipped with teeth, used primarily for loosening hard soil and soft rock.

ROMEX—A non-metallic sheathed cable which contains two or more insulated conductors and a bare ground wire, all within a common covering.

ROOF DRAIN—A drain installed to receive water collecting on the surface of a flat roof and to discharge it into the leader (downspout).

ROUGHING-IN—The installation of all parts of the plumbing, heating, and electrical systems which can be completed prior to the installation of fixtures. For the plumbing system, this includes drainage, water-supply and vent piping, and the necessary fixture supports.

RPM—Abbreviation for revolutions per minute.

SANITARY SEWER—A pipe which carries sewage and excludes storm, surface, and ground water.

SASH—Wood or metal frame into which glass is fastened to fit in a window.

SCARIFIER—An accessory on a grader or roller, used chiefly for shallow loosening of road surfaces.

SCRAPER (or PAN)—A piece of construction equipment, either self-propelled or tractor drawn, used for cutting, hauling, and spreading material.

SEMITRAILER—A towed carrier which rests on a tractor in front, and on its wheels in the rear.

SEPTIC TANK—A watertight receptacle which receives the discharge of a drainage system or part thereof and is designed and constructed so as to separate solids from the liquid, digest organic matter through a period of detention, and allow the liquids to discharge into the soil outside the tank or into a runoff line.

SERVICE SWITCH—The disconnecting point for all interior wiring within a building or structure; also called MAIN DISCONNECT.

SEWAGE—Any liquid waste containing animal or vegetable matter in suspension or solution and may include liquids containing chemicals in solution.

SHEAVE -(Pronounced "shiv.")—A grooved wheel used to support a cable or to change its direction of travel.

SHEEPSFOOT—A drum roller with protruding spikes which are expanded at their outer tips and used for soil compaction.

SHELL—The solid sides of a concrete block or building tile.

SHOULDER—The graded portion of a roadway on either side of the surface course. The shoulder gives lateral support to the surface course.

SIDING—The exterior covering of walls which provides protection against weather and presents a finished appearance, e.g., shingles, wood siding, plywood, panels, or composition siding.

SLING—A lifting device consisting of two or more strands of chain, cable, or line.

SNATCH BLOCK—A single sheave block hinged so that it can be opened to insert a loop of line over the sheave.

SOLDERING—The process of joining two metals by the application of heat and a filler metal having a melting point less than 800°F.

SPARK PLUG—The assembly, which includes a pair of electrodes and an insulator, that provides a gap for the spark in an engine cylinder.

SPECIFICATIONS—The written or printed description of materials, workmanship, etc., that accompanies the working drawings of a building.

SQ. FT. -Abbreviation for square feet.

SQ. IN.—Abbreviation for square inch or square inches.

SSEO—Abbreviation for SEABEE Support and Equipment Office.

STORAGE BATTERY—That part of the automotive electrical system which provides electrical energy primarily for starting.

STORM SEWER—A sewer used for conveying rainwater, surface water, condensate, cooling water, or similar liquid wastes, exclusive of sewage and industrial waste.

STRIPPING—Removing of topsoil and sod.

STUD—Vertical member of the wall framing.

TACKLE (or PURCHASE) — An assembly of blocks and ropes used to gain mechanical advantage in lifting and pulling.

TACK WELD — A temporary weld made to hold parts in proper alignment until the final welds are made.

TAGLINE — A line from a crane boom to a clamshell bucket that holds the bucket from spinning out of position.

TANDEM — A double-axle drive unit for a truck or grader; also called a BOGIE.

TILTING DOZER — A bulldozer whose blade can be pivoted on a horizontal center pin to cut low on one side or the other.

TOA — Abbreviation for Table of Allowance.

TORQUE — A twisting or turning effort.

TRACTOR — A motor vehicle on tracks or wheels used for towing and pushing construction equipment, or when equipped with attachments may be used as a self-contained piece of construction equipment.

TRAILER — A towed carrier which rests on its own wheels.

TRANSIT STATION — An accurately marked point over which the transit is set up.

TRAVERSE — A sequence of lengths and directions of lines between a series of points on the earth.

TRUSS — A built-up framework for supporting loads over a span.

UCT – Abbreviation for Underwater Construction Team.

VERTICAL CONTROL — A system of established bench marks.

VOLTS-AMPS TESTER (V.A.T.) — An instrument used to measure voltage and amperage; essential in checking and adjusting regulation of the electrical charging system on a vehicle.

WATER TABLE — The level below which the ground is saturated with water.

WEB — The partitions inside a concrete block or building tile.

WELDED JOINT — A union of two or more members, the union being produced by welding.

WELDING — The process used to unite metals by heating and allowing them to flow together.

WELDING GOGGLES — Goggles with tinted lenses, used during gas brazing, welding, and cutting, which protect the eyes from harmful radiation and flying particles, and permit the welder to see the flowing metal.

WELDING ROD — A form of filler metal used for arc welding or brazing wherein the filler metal does not conduct the electrical current; also used in gas welding.

WELDING TORCH — A device used in gas welding or torch brazing for mixing and controlling the flow of gases.

WHARF — A waterfront structure used to facilitate the loading and discharge of cargo by providing berthing space for vessels.

WIDE FLANGE BEAM — A structural member with an H-shaped cross section.

WINDROW — A ridge of loose dirt or other material.

WORKING CYCLE — A complete set of operations. With an excavator, it usually includes loading, moving, dumping, and returning to the loading point.

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